

Final Report

**Food Waste Discharge to the Wastewater
Collection System**

**An Evaluation of Current Conditions and
Alternative Management Methods**

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King County Department of Metropolitan Services**

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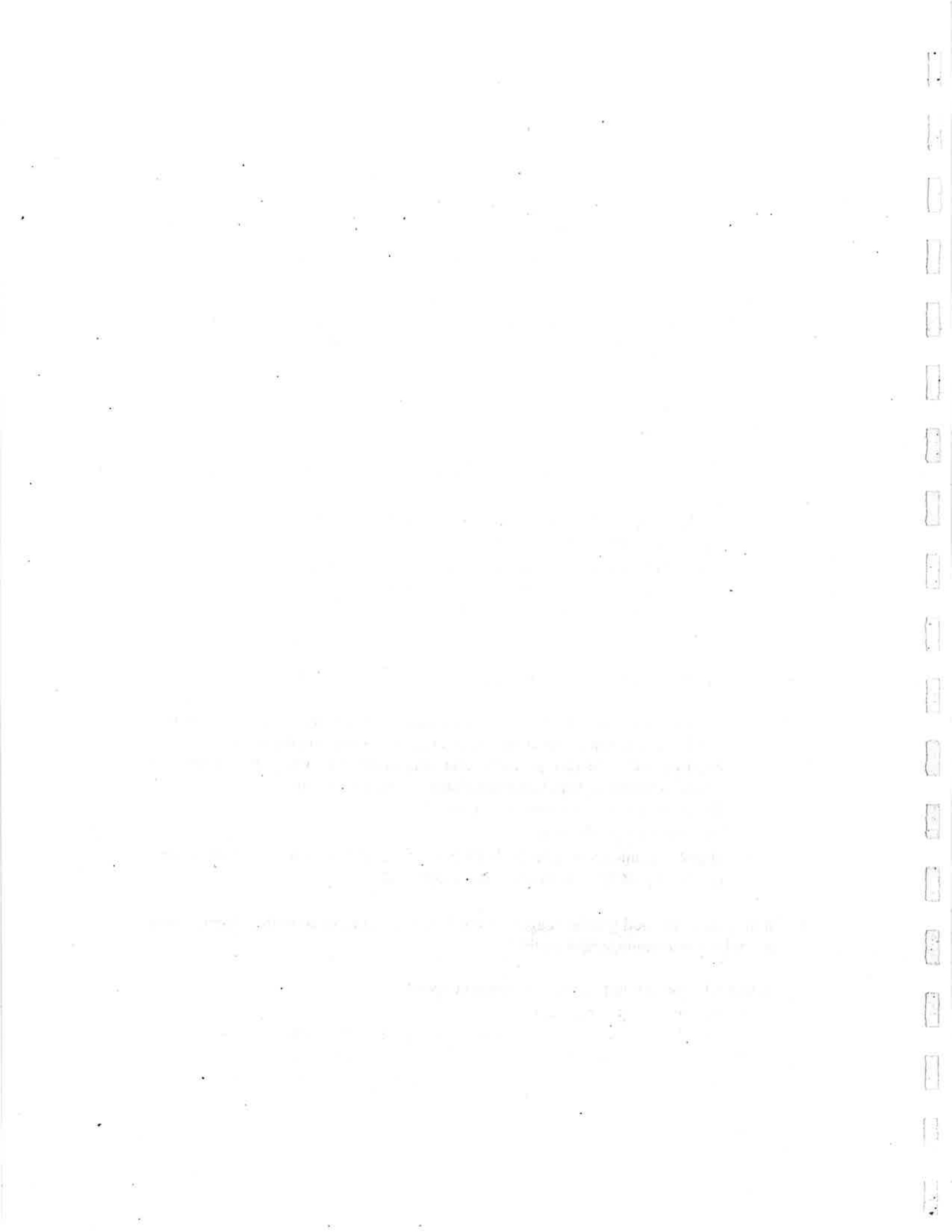
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Primary Project Findings

This evaluation resulted in the following findings and conclusions:

1. Food waste currently discharged to the sewer system represents about 14 percent of the food waste generated in the Metro service area.
2. Food waste discharged to the sewer system is estimated to currently represent about 15 to 18 percent of the organic loading on Metro treatment process units.
3. Food waste is a relatively clean and highly degradable material. Food waste originated material would be expected to digest rapidly with high methane production and would be readily removed in the treatment process.
4. Reducing the discharge of food waste to the sewer system would have the following effects:
 - minimal impact on the quality of biosolids, although metals contents would be expected to increase somewhat.
 - minimal impact on effluent quality requirements, although the 85% removal criteria may result in a somewhat lower effluent BOD concentration requirement at the West Point Treatment Plant (WPTP).
 - An extension of the time before treatment facility expansion is required.
5. Increasing the discharge of food waste to the sewer system would have the following effects:
 - Earlier expansion of treatment facility capacity. A significant diversion of food would have a major impact on treatment plant loading and capacity requirements. The food processing industry in the West Point service area is a potential source of significant unanticipated organic loading.
 - Some dilution of the metals in biosolids.
 - Increased gas production.
 - Higher organic loading on the West Point facility that could potentially raise the facility BOD concentration above 200 mg/L.
6. Management of food grinder usage was not found to be practiced in the United States as a solid waste management method.
7. Estimated costs for non-sewer management options
 - Onsite: \$94 per wet ton
 - Grocery produce waste to yard debris compost facility: \$66 per wet ton
 - Source separated commercial FW collection and composting: \$90 per wet ton
 - Rendering and Reuse of food processing waste: about \$10 per wet ton
 - Collection and Landfilling: \$135 per wet ton



Summary

The objective of this evaluation is to document the current status of food waste management in the Metro service area and the current impact on wastewater treatment facilities, and to develop and compare alternatives for managing food waste in a more cost effective way. The study included analysis of available data on food waste management. Collection and laboratory testing of food waste samples was also included to determine the effect of food waste on wastewater treatment process unit loading.

Policy and Regulation

The utilities in the Metro service area that are responsible for solid waste management are evaluating strategic options for diverting and recycling a portion of the food waste currently disposed of in the garbage. Active programs include backyard "green cone" disposal for residential generators and collection and composting of produce waste from commercial generators. In addition, the City of Seattle and King County have initiated studies of commercial and residential collection and composting as well as on-site composting at commercial businesses. Washington is in the forefront nationally in evaluating food waste management options. Local wastewater agencies have focused on fats, oils and grease, but have done little else to control the discharge of food waste to the sewer system.

Food Waste Grinder Role in Food Waste Management

The food waste grinder is the key instrument for determining how solid food waste is disposed. Solid food waste cannot be washed down the drain on a regular basis without grinding to prevent clogging. Therefore, without external constraints, garbage costs and the cost and convenience of installing and using a food grinder will be the primary factors determining how much food waste goes down the drain and how much goes to garbage collection or on-site use. At this time no significant effort has been made by involved utilities in the Metro service area to encourage or discourage the use of food waste grinders. Several other major metropolitan areas have required or prohibited the installation of food waste grinders.

Only limited data is available on the occurrence and use of food waste grinders in Metro's service area. A study by Seattle Solid Waste Utility provides information on availability and usage by the commercial sector. Information about residential installations and usage is being developed.

Food Waste Quantities

The estimates of food waste generation by source type within the Metro service areas are presented on Table 1.

Summary Table 1 - Year 2000 Food Waste Generation in the Metro Service Area			
	<i>West Point Wet Tons/yr</i>	<i>East Division Wet Tons/yr</i>	<i>Total Wet Tons/yr</i>
Residential	58,900	37,600	96,500
Food Wholesale/Retail	46,700	21,500	68,200
Food Services	63,400	27,400	90,800
<i>Subtotal</i>	<i>169,000</i>	<i>86,500</i>	<i>255,500</i>
Food Processors	138,000	35,600	173,600
<i>Total</i>	<i>307,000</i>	<i>122,100</i>	<i>429,100</i>

This estimate of food waste generation includes all sources of food waste regardless of the method of management. These estimates are higher than previous estimates developed by solid waste utilities because food waste that is reused or discharged to the sewer system have not been included in the earlier estimates.

Food Waste Discharged to the Sewer System

The quantity of food waste currently being discharged to the sewer system under the current management situation was estimated for this study. These quantities were also projected into the future using the growth rates and procedures from the Metro Wastewater 2020 Plan. The estimates are based on the best available information together with a significant amount of professional judgment by the project team. The estimated sewer system discharges of food waste with no change in food waste management are:

Summary Table 2 - Estimated Food Waste Discharge to the Metro Sewer System (Wet Tons)						
	Year 1990			Year 2000		
Sector	<i>West</i>	<i>East</i>	<i>Total</i>	<i>West</i>	<i>East</i>	<i>Total</i>
Residential	11,400	9,100	20,500	13,100	11,100	24,200
Wholesale/Retail	3,200	1,500	4,700	4,200	1,900	6,100
Food Services	13,500	5,800	16,700	17,100	7,400	24,500
<i>subtotal</i>	<i>28,100</i>	<i>16,400</i>	<i>44,500</i>	<i>34,400</i>	<i>20,400</i>	<i>54,800</i>
Food Processors	4,500	1,200	5,700	4,800	1,200	6,000
<i>Total</i>	<i>32,600</i>	<i>17,600</i>	<i>50,200</i>	<i>39,200</i>	<i>21,600</i>	<i>60,800</i>

These estimates indicate that about 21.5 percent (54,800/255,500) of the food waste generated in the Metro service area in the year 2000 by residences, food services and wholesale / retail businesses would be discharged to the sewer system through grinders. Including the food processing wastes, about 14 percent of the food waste is estimated to be discharged to the sewer system in the year 2000.

Food Waste Impact of Treatment Facility Unit Loading

In addition to reviewing literature estimates of food waste impacts on wastewater treatment facility loadings, a test was conducted to evaluate these effects. Food waste samples collected from volunteers during a two day period and synthesized typical food waste samples were used to model: 1) the effects of travel in the sewer system and 2) how the food waste fractionates to provide loading to the primary clarifiers and secondary aeration basins. Based on these tests the estimated loadings on the critical treatment units under current conditions are given on Table 3. The table shows the treatment facility loading that results from the estimated 1990 food waste generation provided on Table 2 for residential, wholesale/retail and food service generators. Food processors are not included in the Table 3 estimates.

Summary Table 3 - Estimated 1990 Food Waste Loading to Metro Wastewater Treatment Units (Dry Pounds per day)						
	West Point Treatment Plant			East Division Reclamation Plant		
	Primary TS	Primary VS	Secondary BOD	Primary TS	Primary VS	Secondary BOD
Food Waste	22,600	18,700	17,100	13,100	10,600	9,700
Total Load	133,300	110,000	98,800	72,800	59,000	67,000
Percent Food Waste	17%	17%	17%	18%	18%	15%

An important finding is that even though only 14 percent of generated food waste is discharged to the sewer system, it still represents 17 percent of the organic loading on the treatment facility. This indicates that a change in food waste grinder usage has the potential to severely impact the capacity of the existing treatment facilities. Food processing wastes represent a fraction of the food waste stream that is not well understood and has the potential to significantly impact treatment facility capacity, particularly in the West point service area because of the number of food processors in that service area.

Food Waste Impact on Treatment Facility Operations and Cost

Removal of food wastes from the influent stream may result in more stringent treatment requirements at West Point Treatment Plant (WPTP). Approximately 17% of WPTP capacity and 8% of East Division Reclamation Plant (EDRP) capacity was dedicated to treating food wastes in 1990. Operational and maintenance costs for Metro to treat and reuse this waste stream are estimated at \$2.4 million in 1990 and projected to increase to \$3.4 million by 2010. Food waste appears to have minimal impact on the quality of biosolids.

Potential for Food Waste Diversion

Based on a range of alternative control strategies the maximum diversion of food waste to and away from the sewer system have been estimated. These estimates (Table 4) are based on reasonable extremes of anticipated participation by generators. Based on these estimates up to 27,000 and 14,000 tons per year of food waste could be diverted from WPTP and EDRP respectively.

Summary Table 4 - Estimated 1990 Range of Discharge of Food Waste to the Sewer System (Wet Tons)			
<i>Management Strategy</i>	<i>West</i>	<i>East</i>	<i>Total</i>
Current Practice	32,700	17,600	50,300
Maximum to Sewers	75,900	37,300	113,200
Minimum to Sewers	5,800	2,900	8,700

Note that a change in disposal economics could result in much greater food processing waste discharge to the sewer system than indicated on this table.

Alternative Food Waste Management Strategies

The objective of the alternative evaluation is to compare the economic and environmental cost of managing food waste through food grinders and wastewater treatment in comparison to other management methods. To accomplish this, alternatives were compared that consider the impact of major food waste management programs on the distribution of food waste among the primary processing options. The alternative considered include:

1. *Current Practice* - No change from current management of food grinder use.
2. *Source Separation* - Discharge to the sewer is discouraged through formation of a food waste separation, collection and processing system to recycle a major portion of the food waste. Variations considered include (A) collection of only commercial waste and (B) collection of commercial and residential waste. The separated food waste would be processed by either composting or anaerobic digestion.
3. *Minimum Food Waste to Sewers* - Discharge to the sewer system is discouraged and no viable options to landfilling are made available.
4. *Maximum Food Waste to Sewers* - Discharge to the sewer system is encouraged.
5. *Minimum Food Waste to WPTP* - The goal of this alternative is to reduce the loading on the West Point Treatment Plant. A source separation program is

established to recycle food waste by composting or digestion, and the use of food grinders is discouraged.

The alternatives were compared considering quantity discharged to the sewer system and potential operational savings. The results are given on the following table.

Summary Table 5 - Alternative Comparison (Year 2000 Conditions)		
	<i>Wet Tons / Yr Food Waste to Sewer</i>	<i>Preliminary Wastewater Treatment Operational Cost (10⁶/yr)</i>
Current	51,800	\$2.8
Source Separation		
Commercial Only		
Composting	44,500	\$2.4
Digestion	44,500	\$2.4
Resid & Commer.		
Composting	36,500	\$2.0
Digestion	36,500	\$2.0
Minimum to Sewer	8,200	\$0.4
Maximum to Sewer System	135,000	\$5.5
Minimum to West Point	24,600	\$1.1

Implementation Recommendations

The intent of this evaluation was to identify potentially viable management methods and additional issues that need to be resolved. Based on the analysis the following implementation recommendations are provided:

1. Consider reducing the discharge of food waste to the West Point service area by implementing education programs. Consider prohibiting the use of food waste grinders within the West Point service area.
2. Investigate the most attractive source separation and processing options in cooperation with the City of Seattle and King County Solid Waste Division.
3. Gather better information of the use of residential food waste grinders.
4. Determine the current disposal practices of food processors and the potential for future wastewater treatment capacity impacts due to changes in practice.
5. Evaluate the effect of current management method fixed costs on the economics of diversion of food wastes to other processing methods.

Section 1

Existing Conditions

1.1 Define Existing Policies and Regulations

The purpose of this section is to describe current activities and anticipated trends regarding food waste disposal within Metro's wastewater treatment service area. A recent study addressing food waste disposal in King County indicates approximately 60 percent of the commercial food waste generated is disposed either in the solid waste stream (landfilled) or through food waste disposals into the liquid waste stream (the remainder is recycled, primarily by renders). Likewise, the majority of residential food waste generated is apparently disposed through the solid waste disposal or wastewater treatment systems. Consequently, the ensuing discussion considers the activities of agencies involved with both solid waste management and wastewater collection and treatment.

At this time, most government agencies have not developed and implemented policies and regulations regarding food waste disposal. However, given the statewide recycling goal of 50 percent by 1998, solid waste agencies are considering alternatives to the landfill disposal of food waste. Prior to this evaluation, agencies responsible for wastewater collection and treatment have not placed much emphasis on the impacts of food waste disposal on wastewater conveyance and treatment systems.

1.1.1 Solid Waste Food Disposal

The City of Seattle and King County both have ambitious goals of reducing the amount of solid waste that is landfilled. Recycling has significantly reduce the amount of solid waste being landfilled. Seattle has a recycling goal of 60 percent by 1998. King County's recycling goal is 65 percent by 2000. In achieving these goals, the City and County have identified food waste as a potential for recycling. Food wastes comprise 12 and 15 percent of the entire solid waste stream in Seattle and King County respectively. In their planning efforts the City and County divide food waste into two categories, residential and commercial. The definition of commercial food waste is broad and essentially includes all food waste that is not from a residential source. The various programs being conducted by Seattle and King County are described as follows.

1.1.1.1 City of Seattle

The Seattle Solid Waste Utility (Utility) currently has several food waste composting programs in the planning stage, as well as a backyard food waste composting program currently being implemented.

Commercial Food Waste Composting

A comprehensive project to examine the feasibility of collecting and composting food waste generated by the commercial sector was recently completed. This project was funded by the Washington State Department of Ecology and was conducted in cooperation with the King County Solid Waste Division. The project included the following main components.

- *Generator Survey* - estimated commercial food waste generation and determined the level of interest and concerns businesses and institutions had regarding the separation of food waste.
- *Collection and Composting Demonstration* - determined technical feasibility of commercial food waste collection and composting, develop facility basis of design information.
- *Product Testing* - examined compost feedstocks and products for a comprehensive suite of product quality and environmental contaminant parameters.
- *Collection and Facility Cost Model* - developed detailed cost estimation models for commercial food waste collection and facility capital, operating and maintenance costs.

The feasibility study results demonstrated that commercial food waste composting was technically feasible. In addition, several of the collection and composting scenarios developed, indicated commercial food waste composting were economically feasible. The Utility is encouraged by these results and is considering internally how a commercial food waste composting facility could be developed. The Utility has essentially ruled out a City owned and operated facility and is internally examining methods for promoting the private development and operation of a commercial food waste composting facility.

Residential Food Waste Composting

The Utility is currently examining the feasibility of providing residential customer curbside collection service of separated food waste. Diverting residential food waste from the disposed waste stream is expected to contribute approximately two percent towards the 60 percent waste reduction and recycling goal. The Utility is conducting a pilot curbside collection study of 900 households during a nine week period lasting from October 24 to December 23, 1994. The projects goals are presented as follows.

- Measure diversion potential of all food waste and food soiled paper versus uncooked vegetative food waste
- Evaluate participants' ability to sort correctly according to these categories
- Assess participants' attitudes towards food waste separation after completing involvement in the collection project

- Collect participant feedback on various types of bags and containers which could be used for future food waste collection pilots and programs
- Identify incentives which may be needed to gain public participation in a curbside food waste collection program.

Food waste setouts will be weighed weekly by the haulers to quantify the amount of food waste disposed by a typical household. A visual assessment of inert contamination levels (plastic, glass and metal refuse) will be conducted. At the conclusion of the pilot, all 900 participants will be contacted by phone to obtain feedback on how difficult it was to separate food waste, problems encountered, and whether they continued to use their food grinders. In addition, the Utility will conduct two focus groups in January involving about 24 participants to obtain more detailed feedback about containers and bags which could be used in future food waste collection pilots and programs, and identify incentives for separating food waste for curbside collection or backyard composting. In a related matter, a random telephone survey of 600 Seattle residents will be conducted at the end of 1994 on practices and attitudes towards yard and food waste disposal.

Backyard Food Waste Composting

This project was undertaken by the Utility to assess the feasibility of backyard composting as an alternative to divert food wastes from being landfilled. In 1994, the Utility distributed "green cones" to 2,000 Seattle residents for backyard food waste composting. The public was introduced to the food waste composters, or green cones, through several workshops conducted throughout the city. A green cone consists of a double-walled cone-shaped section with a lid on top which sits above ground and a laundry basket section that is buried two feet into the ground. At the workshops participants are provided instructions on how to assemble, install and use the green cone, as well as harvest the final product. Trainers also discuss food waste composting as an alternative to using food waste grinders. A telephone survey of green cone users will be conducted in the spring of 1995 to obtain feedback on the ease of using the unit and level of satisfaction.

The backyard food waste composting program is an outgrowth of the residential yard waste composting program, which has been conducted by the city since 1989. In 1992, the Utility conducted a pilot food waste composting project involving 250 volunteer households who were given one of four units to be tested. The participants were asked to weigh all food waste composted in the unit as well as all other food waste generated. The results of the pilot showed that the average household generated about 370 pounds of food waste per year, and that 81% (300 pounds) of the food waste can be composted.

1.1.1.2 King County

The King County Solid Waste Division is currently conducting several planning activities that address food waste composting. These activities are described as follows.

Commercial Food Waste Composting

The King County Solid Waste Division (County) was a co-manager of the commercial food waste composting project described above. The County is currently reviewing the findings from this study and considering the full scale implementation of commercial food waste composting.

The County is also currently conducting a project to examine the feasibility of on-site commercial food waste composting. On-site composting is of interest as it can eliminate food waste collection and hauling costs. Furthermore, an on-site composting system does not require a costly solid waste handling permit. Project results to date indicate there is some interest at the commercial level regarding on-site food waste composting. However, capital and operating costs are of concern. Accordingly, this project will develop capital and operating costs at five locations in order to address economic feasibility. Based on the results of the feasibility study, the County may choose to conduct a pilot scale on-site composting demonstration project.

King County Residential Food Waste Composting

The King County Solid Waste Division (KCSWD) is planning a pilot project to test the effectiveness of food waste composting in the residential sector. The project is currently in the planning stages and the KCSWD has not decided on details of the pilot project. The KCSWD's preference is to evaluate a curbside food waste collection program, but is also considering a backyard program. The KCSWD has sponsored a residential backyard compost bin distribution program for the last five years to divert yard waste from the disposed waste stream. Participants have been instructed to not add food waste to the yard waste composters which are not rodent-proof. The food waste pilot is seen as the next step towards further diversion. Food waste generated by the residential sector of King County has been estimated to comprise six percent of the total disposed solid waste stream.

1.1.1.3 Other Activities

Several other activities related to food waste composting are occurring within Metro's service area. These activities are described as follows.

Organic Grocery Debris Composting

Three composting facilities within Metro's service area are permitted by the King County - Seattle Health Department to compost pre-consumer, vegetative food wastes. These composting services are primarily provided for use by grocery stores. In addition to food waste, other compostable, non-recyclable materials generated by grocery stores, such as wax coated cardboard, soiled paper and wooden vegetable crates are also being composted.

Use of these services is becoming more common as participating grocery stores are saving approximately 25 percent on their refuse disposal costs. Some food processors, wholesale

produce distributors and vegetarian restaurants are also utilizing this composting service. Discussions with waste haulers, composters and grocery store management indicate the amount of grocery waste composted will rapidly continue to expand. A review of the participating composting facilities and their clients is provided as follows.

- *Cedar Grove Compost, Inc.* - Composts organic grocery debris from 20 QFC stores, eight Safeway stores and several produce houses, and also accepts food wastes from several vegetarian restaurants.
- *Iddings, Inc.* - Has been composting organic grocery debris from the Larry's markets grocery chain for four years
- *Lloyd's Enterprises, Inc.* - Composting a variety of food processing residuals from Nalley's Fine Foods of Tacoma.

Issaquah Eco-Center

The City of Issaquah is beginning the construction of a small convention center that will also serve as a center for accepting difficult-to-recycle items such as fluorescent glass bulbs. An on-site composting system is planned as part of the facility. In addition, the City is planning a residential food waste composting study. This pilot study could potentially result in a full scale residential food waste composting program for Issaquah.

Clean Washington Center

The Clean Washington Center (CWC), a division of the Washington State Department of Community, Economic Trade and Development, is charged with the mission of developing markets and technologies that promote recycling and the use of recycled products. The CWC has been actively developing and disseminating technical information regarding the composting of food waste. A primary objective of the CWC's staff is to provide technical information to private and public entities interested in developing new composting programs or expanding existing programs. Consequently, the CWC is a valuable resource for private and public entities interested in composting food waste.

1.1.2 Wastewater Disposal of Food Waste

The use of food waste grinders for disposing commercial and residential food waste into the sanitary sewer is an established practice within Metro's service area. Food waste disposal is a concern for Metro's Industrial Pretreatment Program and the sewer districts within Metro's service area. The Industrial Pretreatment Program is concerned primarily with the strength of the influent whereas the sewer districts are concerned with flow impedance in the collection system. In addition to contacting Metro personnel, personnel from 10 of the larger sewer and water districts were contacted to determine what activities were being conducted to reduce food waste disposal to the sewer.

1.1.2.1 King County Division of Metropolitan Services (Metro)

Metro currently has an ordinance (Ordinance 11034) that specifies any food waste disposed to the sewer must be processed small enough to pass a 1/4 inch sieve. This is the only restriction regarding the sewer disposal of food waste. This requirement was developed in 1976 with the intent of eliminating the impedance of sewer lines by food waste. This ordinance was not intended to encourage or discourage the use of food grinders.

Annually, Metro administers approximately 50 waste discharge permits to food processors, fish processors, bakeries, and breweries as part of its industrial pretreatment program. The permits are valid for a five year period. A facility that discharges a wastestream having a biological oxygen demand (BOD) greater than 300 milligrams per liter or a total suspended solids (TSS) concentration greater than 400 milligrams per liter is considered an industrial source and is thereby assessed a fee for its BOD and TSS loadings.

Metro inspects this type of industrial facility once a year, at a minimum, and monitors the waste strength of the effluent for BOD and TSS one to two times per year. The purpose of monitoring the waste strength is to assess a sewer fee surcharge. Metro's 1994 fee schedule specifies a charge of \$122.37 per 1,000 pounds of BOD and \$186.24 per 1,000 pounds of suspended solids. Metro calculates surcharge fees and industrial clients are invoiced by their local agencies. A facility that discharges greater than 600 pounds of BOD per day is required to obtain a waste discharge permit.

The 1/4 inch size limit for food waste disposal is not monitored directly, but is addressed qualitatively during the inspections. Metro has been able to get the majority of businesses to correct any problems identified during inspections.

1.1.2.2 Water and Sewer Districts

Metro provides wholesale wastewater treatment services to Seattle-area cities and sewer districts. These services include transporting and treating wastewater from each City's/district's wastewater collection system. Each City or district has responsibility for operating and maintaining its wastewater collection system, as well as invoicing customers for their sewer use. Metro in turn, charges the City or district based on the volume of wastewater received. Metro is responsible for maintaining the trunk line collection system that the various water and sewer districts feed into.

A total of 11 sewer districts within Metro's service area were contacted to determine if the districts are actively promoting or discouraging food waste disposal to the sewer. The results of these contacts are presented in Table 1.1.2.2. Only the City of Bellevue is making a concerted effort to reduce or encourage the use of food waste grinders.

Interestingly, 4 of the 11 districts surveyed indicated that food waste had caused a problem in the wastewater collection system.

All of the districts surveyed either require or strongly encourage the use of grease traps for commercial customers. Grease removal is also of significance since flow restrictions within the collection system are typically caused by grease buildup. Seven of the eleven districts surveyed stated they have experienced problems in the collection system as a result of grease disposal.

The City of Bellevue has initiated several activities aimed at reducing the amount of commercial food waste disposed in the sewer system. Don Boll, an industrial waste coordinator, has been responsible for leading this effort.

The City's goal is to reduce grease and food waste buildup in the collection system that, in turn, restricts the flow and increases maintenance. This effort primarily entails encouraging restaurants to remove their food grinders and to install grease traps with biotreatment.

Mr. Boll does not conduct inspections and has not followed up formally to assess the degree to which the restaurants have followed this advice. Although he has not conducted any studies that evaluate the effects of these activities on the collection system, he has observed a marked improvement on the maintenance requirements. Several noteworthy efforts within the City of Bellevue's jurisdiction aimed at reducing food and grease waste disposal are as follows.

- *Meydenbauer Convention Center* - At this recently constructed convention center, a pulper/extractor to dewater food waste was installed as an alternative to food waste grinders. All food waste is processed in the extractor and the residual is disposed in the dumpster. In addition to food waste, cardboard is also processed in the pulper extractor to reduce volume. The engineering firm working on the center's design estimated that the facility will save approximately 1 million gallons of water per year by not installing food grinders.
- *Bellevue School District* - A pulper extractor was recently installed at the kitchen of the Tyee Middle School instead of food waste grinders. The ease of using the extractor and the effect on the collection system have not been studied.
- *Bellevue Square* - Bellevue Square, a major retail shopping center, has approximately 40 restaurants. The grease buildup in the lines to the center was requiring the center's management to regularly clean out those lines. The collection system maintained by the City of Bellevue was also affected down line from the center. Don worked with the individual restaurants to install grease traps in conjunction with biotreatment in the kitchen sinks. He also worked with the center's management firm to install an

interceptor. These measures have been effective in alleviating collection system problems.

1.2 Food Waste Grinder Technology

An understanding of food waste grinder technologies and practices is necessary for developing food waste disposal/utilization alternatives for controlling food waste discharge to the sewer system. In order for alternative disposal methods to be accepted, it is important to understand both the benefits and costs associated with their use in both the commercial and residential sector. The primary objective of this task is to describe how these devices are being used and in particular, define the energy, power, labor and water requirements of food waste grinders.

1.2.1 Summary of Commercial and Residential Food Grinders

Several restaurant supply businesses and home hardware stores were contacted by telephone or visited to obtain lists of commercial and residential food waste grinder manufacturers. In addition, the store personnel were queried to determine which manufacturer's equipment was most prevalent. Several manufacturers were in turn contacted to obtain food waste grinder specifications and to determine water, power and labor requirements for specific units.

In developing the scope for this task it was anticipated that manufacturers would be able to provide detailed information regarding energy, water, and labor requirements per unit of food waste disposed. However, this level of information was not commonly available in the manufacturers product specifications, nor was it obtainable from the manufacturers through telephone conversations. Surprisingly, there is a paucity of detailed information regarding energy, water and labor requirements for food waste disposals.

A company representative for a manufacturer of commercial food grinders indicated energy, water and labor requirements per unit of food waste does not exist because food waste characteristics and composition vary widely; soft materials such as gelatin and lettuce are readily ground where as other materials such as meat scraps and bones take considerably more time to pass through a kitchen grinder. Consequently, it would be difficult to develop standard testing procedures for determining energy, water and labor requirements per unit of food waste.

1.2.1.1 Residential Food Waste Grinders

Several visits to home hardware stores and discussions with factory representatives indicated Emerson Electric and Anaheim Manufacturing were the primary manufacturers of residential food waste disposals. Emerson Electric produces a number of different makes and models of residential food waste disposals, including In-Sink-Erator (ISE) and

the Kenmore food waste disposal retailed by Sears. A factory representative indicated that Emerson Electric manufactures approximately three million of the four million residential food waste grinders sold annually. Anaheim Manufacturing also produces several different product lines including Waste Thermador, Waste King, Sinkmaster (distributed by Frigidaire) and Hushmaster.

A review of the product specifications for residential food waste grinders indicates they typically are equipped with 1/3 to one horsepower motors. Very little information regarding energy and water requirements on a daily or per unit of food waste disposed was found in the product specifications. most of the Emerson Electric model specifications indicated daily water usage was 1.5 gallons. A general piece of literature produced by Anaheim Manufacturing indicated residential food waste disposals use on average, six gallons of water per day. An informal survey of six plumbers indicates residential units are typically operational for eight to ten years.

A review of the literature provided some estimates on residential food waste grinder water use, which are summarized in Table 1.2.1.1. The various references presented indicate daily residential garbage disposal water use ranges from 1.5 to 6.2 gallons of water per household. Per capita - day use ranges from 0.75 to 2 gallons. This water use is small in contrast to the total residential water use of 40 to 70 gallons per capita-day (not including lawn and garden water use). This information indicates the use of residential food grinders accounts for approximately one to five percent of the total per capita-daily water use.

Table 1.2.1.1		
Residential Food Waste Grinder Water Use		
Study	Per Household (gallons per day)	Per Capita (gallons per day)
Watson, 1963	4.2 - 6.2	
Bailey et al., 1969 ^a	3	0.75
Metcalf & Eddy, 1979		1 - 2
Emerson Electric, 1994	1.5	

1.2.1.2 Commercial Food Waste Grinders

Several site visits and telephone contacts with restaurant supply businesses indicated there are several companies that manufacture commercial food waste grinders. Based on these contacts it appears Emerson Electric and Hobart manufacture a large portion of the commercial food waste grinders. Other manufacturers include Master Disposer, American

Delphi, Anaheim Manufacturing (Thermador, Sinkmaster, Waste King), Bus Boy, Salvajor and Red Goat.

In general, the motors powering the commercial units were noted to range from 1/2 to 10 horsepower. As for the residential food waste disposals, very little information was found regarding energy, water and labor requirements on a daily or per unit of food waste disposed basis. For some units, the water required for flushing the ground food waste is provided automatically when the unit is turned on by way of a dedicated pipe plumbed into the unit. Specifications for these types of units provide information on water flow rates (gallons per minute) required. A summary of the commercial and residential lines produced by several manufacturers are presented in Table 1.2.1.2.

Table 1.2.1.2 Summary of Commercial and Residential Food Waste Grinders^a				
Manufacturer	Horsepower	Meals/Day	Water Use (gpm)	Power Use^b (kw hrs/yr)
Hobart	1 1/4	200-300	5	681
	1 1/2	300-500	8	817
	2	500-1000	8	1089
	3	1000-2000	8	1634
	5	2000-4000	10	2723
Sinkmaster (Anaheim Manufacturing)	1/3	na	na	182
	1/2			272
	3/4			408
	1			545
Waste King (Anaheim Manufacturing)	1/2	na	5	272
	3/4		5	408
	1		5	545
	1 1/4		5	681
	1 1/2		8	817
	2		8	1089
	3		10	1634
	5		10	2723
	10		10	5446
In-Sink-Erator (Emerson Electric)	1/2	na	3	272
	3/4		3	408
	1		5	545
	1 1/4		5	681
	1 1/2		7	817
	2		7	1089
	3		8	1634
	5		8	2723
	7 1/2		10	4084
Salvajor	10		10	5446
	1	na	5	545
	2	200-500	5	1089
	3	500-2000	8	1634
	5	2000-4000	8	2723
Red Goat	7 1/2	4000-6000	8	4084
	1	500 ^c	na	545
	1 1/2	800		817
	2	1200		1089
	3	1700		1634
	5	2200		2723
	7 1/2	3000		4084
	10	5000		5446

a Obtained from manufacturers specifications

b Assumes all units are run 10 minutes per hour, 12 hours per day

c Red Goat numbers in meals per hour

1.2.2 Field Observations of Food Waste Grinder Usage

Site visits to several commercial and institutional entities was conducted to observe the use of food waste grinders in the commercial sector. The sites visited included restaurants, grocery stores, a retirement home, and an elementary school. Attending the tour was a representative the King County Health Department. The Food Program Inspector led the tour to several of his inspection sites. As part of a commercial on-site food waste composting feasibility study conducted for the King County Solid Waste Division, food waste grinder usage at a school and three additional restaurant sites was

observed. The intent of these site visits was to observe how food waste disposal units are being used in commercial and institutional establishments.

A survey form was designed to gather information on the number of grinders as well as the grinder make, model, horsepower, years in use, and frequency of use. The type of food wastes placed in the grinder and the frequency of maintenance were also noted. In addition, an attempt was made to determine the food waste disposal rate as well as the flow rate of the water used by each unit. Although these parameters were not determined for all of the units because of lack of access to food waste or the provision of water to the unit through an internal source, some valuable information was gathered.

Prior to conducting the site visits, information was provided regarding the use of food waste grinders by the commercial sector. As an inspector for King County Department of Health for 25 years the inspector is very familiar with how food grinders are used and feels that food waste grinders are not used extensively by the restaurant industry. The large chains would be most likely to have food waste grinders, and the small restaurants in his area typically do not have them.

A total of fourteen establishments were visited, including one retirement home, two schools, two grocery stores and nine restaurants. Observations from the site visits are summarized in Table 1.2.2. In general, most of the establishments visited had food grinders (9 of 14); however, only four of the 14 sites were noted to use food grinders extensively. Food grinders were noted to be used minimally. More detailed descriptions of food grinder usage are provided as follows.

Table 1.2.2 - Site Visit Observations Summary				
Name of Business	Type of Business	Grinder Installed	Type of Grinder	Comments on How Grinder is Used
Grocery Stores				
Safeway	grocery	yes, 2	Garb-el AR-57-FB, 5HP Waste King 1000-8, 1HP	6-7% of all produce stock is thrown away, 25% of this is disposed through the grinder. The second disposal unit is used in the deli for food waste.
QFC	grocery	yes	Garb-el AR-56-FB, 5HP	Estimate 30 gallons of waste disposed per day, half of which is dense food requiring extra water (4 gal water/gal dense food). A test run showed that 5 gallons (9 lbs) of lettuce took 1.5 minutes to grind with no extra water added. The unit has an internal water source
Institutions				
Olympic View Elementary	school	yes	ISE SS-200-21, 2HP	Food grinder is rarely used
Tillicum Middle School	school	yes	ISE	Food grinder is rarely used
Northgate Plaza	retirement home	yes	ISE SS-200-29, 2HP	Estimate 30 gallons per day of meal scraps disposed through the grinder
Restaurants				
Marie Callenders	restaurant	yes	ISE SS-300-25, 3HP	Food leftovers are ground, no estimate of quantities
Fresh Choice	restaurant	no	not applicable	New restaurant
Sizzler	restaurant	no	not applicable	Never had a food waste grinder
Tony Romas	restaurant	no	not applicable	Not installed for safety and maintenance reasons
Dennys	restaurant	no	not applicable	Used to have grinder, removed it for maintenance reasons
Skippers	restaurant	no	not applicable	Never had a food waste grinder
The Keg	restaurant	yes	not determined	Table wastes scraped into trash
Zoopla	restaurant	yes	not determined	Table wastes scraped into trash
Palisade	restaurant	yes	not determined	Table wastes scraped into trash

The two grocery stores visited were both noted to rely on food grinders for disposing unsalable produce stock. The Safeway store estimated approximately 25 percent of the unsalable produce waste is disposed through the grinder. The QFC store estimated approximately 30 gallons of food waste are disposed through the grinder daily. Assuming the food waste has a density of 1,000 pounds per cubic yard, 30 gallons is equivalent to approximately 150 pounds. Water use at the QFC store was estimated to be 85 gallons per day or 0.6 gallons per pound of food waste disposed. This estimate assumed:

- The internal water source provided 5 gallons of water per minute of grinder operation

- One half or 15 pounds of the daily food waste disposed was readily ground and took a total of 5 minutes to dispose
- One half or 15 pounds of the food waste was more difficult to grind and required four gallons of water per gallon of food waste to dispose

Institutions visited included two public schools, from the Seattle and Bellevue School Districts, and a retirement home. Both schools were noted to have grinders, but at both locations, they are seldom used. Most of the food consumed at both schools is prepared elsewhere and shipped in. Consequently, there is very little pre-consumer food waste generated in the kitchens. All of the meals for the Seattle School District schools are prepared in two school kitchens and shipped to the other schools, which have kitchen practices similar to Olympic Terrace Elementary School.

Post consumer food waste generated at the schools contains a large amount of non-food waste including plastic service ware, napkins, paper bags, milk containers and other items that are not suitable for disposal through a food waste grinder. Consequently, no post-consumer food waste is disposed through the food grinders. At the Tillicum Middle School, the students actively source separate recyclable materials which include glass, aluminum cans, milk cartons and styrofoam lunch trays. The school is very interested in diverting food waste and other compostable materials to an on-site composting program.

A retirement home located in the Northgate area was also visited. This facility is one of 11 operated by the parent company in the Seattle area. All 11 of the retirement homes use food disposal units, and the manager we spoke with felt it was fairly universal within the industry. Approximately 30 gallons or 150 pounds of food waste are disposed through the garbage grinder at the Northgate Plaza Retirement home

Of the nine restaurants visited, only four had food grinders installed, of which only one was being used as a means for disposing a large portion of the food waste generated. The Keg, Zoopa and Palisade all have food grinders installed where water is discharged from the automatic dishwasher. However, most of the post-consumer food waste is routinely scraped off plates into the trash. Pre-consumer food wastes are also disposed into the trash. As a result, very little food waste is disposed through the food waste grinders at these three restaurants. The grinders are essentially used as a means on keeping the drain clear of the small amount of food waste that is not scraped off the plates.

Marie Callenders, the one restaurant that routinely uses a food waste grinder to dispose food waste has a concern about the additional water and sewer costs resulting from the use of the food grinder. However, they are not sure how much the use of the food grinder costs compared to solid waste disposal. Many of the restaurants visited were noted to not have food waste grinders installed. Several of the managers questioned stated that there were specific reasons for the absence of grinders. These included:

- *Worker safety* - Grinder units pose a liability issue and are considered too high a risk by some managers.
- *Reliability and Maintenance* - Restaurants rarely have dual units (redundancy), so when a grinder fails, it causes a major disruption in kitchen operation. Concern was also expressed about the impact of disposing all food waste generated on the operation of the drain and grease trap.
- *Worker training issues* - Related directly to maintenance is the issue of training workers to separate out foods not suitable for grinding. The manager at Tony Romas stated that this was a problem since they specialize in ribs.
- *Cost for sewer disposal* - The manager at Marie Callenders stated that if a new restaurant went in he would recommend that it not be equipped with a grinder unit because of the cost of the disposal of the water through the sewer system.

1.2.3 Commercial Food Waste Generation Survey

As part of the Seattle/King County Commercial Food Waste Composting Project, a random sample of commercial food waste generators was surveyed to address a variety of issues regarding food waste composting. A primary survey objective was to determine how food wastes are being disposed and one of the survey questions asked what percentage of the food waste generated was disposed down a garbage disposal or food grinder. The response to this question is presented in Table 1.2.3. These survey results are provided for the purpose of comparison to the site observations.

Table 1.2.3 - Commercial Use of Food Grinders for Food Waste Disposal					
Generator Type	# Surveyed	Percent of Food Waste to Grinders ^a			
		none	< 50%	50 - 100%	no answer
Food processors ^b	24	13	14	0	73
Wholesale/retail ^c	47	56	8	6	29
Food service ^d	156	27	34	13	26
^a Estimated percent of food waste generated by business that is disposed of via food waste grinder ^b Includes: bakeries, fish and meat processors, breweries and dairies, among others ^c Includes: food wholesalers, grocers and other food retailers ^d Includes: restaurants, schools, in-patient care facilities, and lodging establishments					

1.2.4 Case Studies

A search was conducted to identify six municipalities that have implemented policies regarding food waste disposal that were more pro-active than Metro's. In particular the search sought communities that have:

- implemented programs that either encourage or prohibit the use of food waste grinders,
- a policy of assessing surcharges for the commercial use of food waste grinders,
- implemented some other innovative program addressing the use of food waste grinders.

The search entailed informal discussions with people in the wastewater treatment industry. The National Association of Plumbing, Heating and Cooling Contractors Education Foundation has a program to promote the installation and use of food waste grinders and provided a list of 90 communities that have mandated food waste grinder usage. Once the municipalities were identified, they were contacted to gather key information and develop a brief case study report.

The search identified three municipalities (New York City, Toronto and Orillia, Canada) that prohibit the use of food waste grinders and three municipalities that mandate the use of grinders. The programs for each of these municipalities are summarized in Appendix A.

Section 2

Residential and Commercial Food Waste Generation and Contribution to the Metro System

The objective of the Metro Food Waste Grinder Study is to estimate waste loading factors (hereafter WLF) for food waste from each of the major waste generating sectors in the Metro East and West Division Service Areas. This section describes the derivation of the base case loading factors for residential, food processors, food services, and food wholesale/retail sectors for the period of 1990 through 2010. Loading factors for high and low discharge rates are estimated. These scenarios model the impact of alternative solid waste programs, pricing policies, and regulations that are intended to change behavior by encouraging or conversely discouraging disposal through food waste grinders. The base case represents a reasonable estimate of the discharge to the sewer system with the current management approach. The high estimate represents the anticipated result of a strong program to encourage discharge to the Metro system. The low estimate is based on a strong program to discourage sewer discharge.

2.1 Overview of Methodology

This study identifies the major food waste generating sectors, their respective contributions to food waste loadings, and total food disposal through grinders in the Metro East and West Division Service Areas.

The basic equation for food waste disposal is:

$$\text{Sector Loading} = \text{Waste Loading Factor} * \text{Generating Units}$$

This equation states that food waste for each generating sector is the waste loading factor multiplied by the number of generating units (i.e. people or employees). In this study, four sectors were examined:

- Residential--single and multiple family residences
- Food Processors--manufacturers of food products (SIC 2011-2099)
- Food Wholesale/Retail--food wholesalers (SIC 5141-5149) and grocers and other food retailers (SIC 5411-5499)
- Food Services--eating establishments (SIC 5812)

The commercial sectors were identified by *Seattle's Food Waste Collection and Composting Demonstration Project*¹ as the major non-residential food waste generators. These generating sectors were examined for two geographic regions: the East Division Service Area and the West Division Service Area.

To estimate food waste loadings in the Metro Service Areas, three basic steps were necessary, including:

1. assembling employment or population data for each generating sector;
2. allocating employment and population data to the relevant basin, and
3. estimating Waste Loading Factors for each sector.

The following sections of this document describe the methodology used to derive each of these data elements.

2.2 Population and Employment Data

The *WasteWater 2020 Existing Conditions Report* developed a computer model to allocate population and employment in each forecast area to the appropriate wastewater basin. This model, referred to as the Growth Management Forecasting Model (GMFM), considered factors such as the implementation of the Growth Management Act, open spaces, critical habitat, and other geographic issues in determining wastewater flows. The model is fully explained in the *Existing Conditions Report*.

In this current project, the methodology of the GMFM is used to estimate residential and commercial food waste loadings. Residential populations, and the appropriate allocation to service basins, are taken from the GMFM output and used to compute residential generation. Commercial employment is not readily assignable to geographic regions using the GMFM methodology. Because of disclosure constraints, it is not possible to obtain employment data for each SIC grouping for each geographic region considered by the model.² Department of Employment Security employment data for groupings of Forecast and Analysis Zones (FAZs) was used to assign all commercial employment to FAZs completely inside the Metro service areas. This assignment was on the assumption that any large commercial employer, such as food processors, is likely to be sewerred and therefore connected to the Metro system.

2.2.1 Population Data

This study uses the same population data and forecasts as those the Puget Sound Regional Council (PSRC) developed for Metro's *Waste Water 2020 Existing Conditions Report*. For 1990 and 2000, the baseline forecasts were used while for 2010 the Vision 1 forecast was used. The following table presents the sewerred residential population in the East and

West Division Service Areas in 1990, 2000 , and 2010, as developed from the PSRC. The total population was adjusted to account for non-sewered population in each of the Service Areas as presented in the Population and Flow Projection Tables Appendix of the *Existing Conditions Report*.

Table 2.2.1 - Metro Sewered Residential Population			
	1990	2000	2010
East Division Service Area	434,330	529,695	607,215
West Division Service Area	723,894	832,528	962,072

2.2.2 Commercial Employment

Employment data for 1990 were provided for these groupings of Standard Industry Classification (SIC) codes by the Office of Labor Market and Economic Analysis in the Washington State Department of Employment Security. Employment data were collected for three waste generating sectors:

- Food Processors: SIC 2011 - 2099
- Food Wholesalers/Retailers: SIC 5141-5149, 5411-5499
- Food Services: SIC 5812, 7011, 8211-8222

This study forecasts employment in 2000 and 2010 from PSRC data contained in the *Existing Conditions Report*. To forecast the 2000 and 2010 values, we used the PSRC rate of change for the retail sector and applied it to the Food Wholesale/Retail sector and the Food Service sector. For the Food Processing sector the rate of change for the manufacturing sector was used.³ Table 2.2.2 presents the 1990, 2000, and 2010 employment values for the overall sectors.

Table 2.2.2 - Employment in Major Food Waste Generating Sectors (1)							
Sector	SIC	1990		2000		2010	
		East	West	East	West	East	West
Food Processors	2011-2099	1,720	6,690	1,843	7,167	1,974	7,679
Food Wholesalers/Retailers	5141-5149,5411-5499	6,721	14,567	8,514	18,453	10,786	23,376
Food Services	5812,7011,8211-8222	12,714	29,457	16,105	37,316	20,402	47,271

(1) 1990 Data from Department of Employment Security; future forecasts use PSRC growth rates

2.3 Waste Loading Factors

Food waste currently treated at waste water facilities is only a portion of the overall food waste generated by residents and businesses in Metro's service area. Some food waste is disposed with other solid waste, some is composted, some is recycled through rendering, and some is ground up and sent "down the drain".

Most studies that estimate food waste generation or disposal are interested in food waste that is destined for solid waste disposal. In this study, total food waste generation was estimated including food waste disposal via food grinders and reused food processing wastes.

2.3.1 Residential Food Waste Loading Factors

The number of tons of food waste (including water fraction of food waste but not flushing water) discharged to the sewer system by residential customers is estimated based on (1) a residential waste generation rate, (2) a food waste "capture" rate, (3) the number of households in each service area, and (4) an assumed percent of houses with grinders. The first step in estimating residential food waste loading factors is determining the total amount of food generated by single family residential households. A recent *Program Evaluation for Seattle Food Waste Composting Pilot Study*⁴ is the only known source of single family food waste generation rates in the Northwest. A food waste generation rate of 0.071 wet tons per person per day for single family residences was derived using the results of this study.

Not all homes have food waste grinders; however, newer homes are more likely to have grinders. Using information provided by the Seattle-King County Department of Public Health⁵, estimates of the number of residential grinders by age of housing stock were developed. This analysis indicated that 40% of homes built prior to 1950 have disposals while 70% of homes built between 1950 and 1970 have disposals, and that all homes built after 1970 have disposals. Census data were used to estimate the number of households by age category and then to estimate the number of grinders for both the East Division and West Division Service Areas. These estimates combined with a grinder "capture rate" were used to derive the number of wet tons being disposed by residential customers in both Service Areas. Table 2.3.1 develops the estimates of the number of homes in each area with grinders. Based on this data, 84% of East Division homes have food grinders while only 63% of the West Division homes have food grinders.

Table 2.3.1 - Calculation of Food Grinder Usage					
Age of House	Percent w/grinders	Number of Residential Households			
		East Div.	w/Grinders	West Div.	w/Grinders
1900 to 1950	40.00%	26,222	10,489	133,117	53,247
1950 to 1970	70.00%	88,022	61,615	80,862	56,603
1970 to 1994	100.00%	151,762	152,762	70,943	70,943
Average Number with Grinders			84.22%		63.45%

A second calculation is necessary to estimate food waste loadings. A “capture rate” is used to describe the percentage of food waste which is actually disposed through grinders. All food waste does not “go down the drain”. Some food waste such as bones, are usually disposed with solid waste. In some cases, households may use their grinders infrequently or for only a few items such as vegetable trimmings. As a result, far less food is disposed through grinders than is generated. We estimate that 35% of food waste generated within homes having grinders is discharged into the sewer system. Due to a complete lack of data on residential grinder use, this estimate is a mid-range assumption between high-end and low-end “capture rates” for residential households. A range was provided to account for the limited information regarding capture rates. The high-end is assumed to be about 65% (80% of the population disposing 80% of its food waste through grinders)⁶ while the low-end is assumed to be approximately 5% (20% of the population diverting 20% of food waste to the sewer).

The assumption of a 35% “capture rate” is supported by diversion data from Seattle’s residential curbside recycling program. On average, single-family households recycled from 25% to just over 50% of common household recyclables through this program. These materials and their curbside recycling rates include:

- Newspaper 41%
- Corrugated Cardboard 26%
- Mixed Waste Paper 52%
- Glass 50%
- Tin Cans 31%
- Aluminum Cans 25%

The overall curbside recycling rate for these materials is about 42%.

A recently completed, unpublished survey by the Seattle Solid Waste Utility also supports our 35% assumption. In this phone survey of 610 Seattle single-family households, respondents with grinders (43%) reported disposing, on average, about 31.5% of their food waste through grinders.

The calculations described below produce the final estimates of food waste disposal in the East and West Divisions. The calculations are as follows:

Grinder disposal in the *East Division Service Area*:

.071 tons of food per capita * 35% of food waste in grinders * 84% of households with grinders

= .021 tons/capita/year/for the East Division Service Area

Grinder disposal in the *West Division Service Area*:

.071 tons of food per capita * 35% of food waste in grinders * 63% of households with grinders

= .016 tons/capita/year/for the West Division Service Area

2.3.2 Commercial Food Waste Loading Factors

Food Services

Information gained from 48 site visits to food service establishments, conducted as part of the *Seattle Food Waste Collection and Composting Demonstration Project*, documents an average grinder disposal rate of .975 tons per employee per year. Survey data⁷ from 156 randomly selected food service businesses indicate that 47% of these generators have, and use, grinders. The food waste loading factor for food services, is the product of the grinder disposal rate, times the percent of businesses using grinders, or .458 tons of food waste per employee per year in both the East and West Division Service Areas.

Food Wholesale/Retail

The City of Seattle is currently conducting a commercial food waste weighing study⁸, to determine solid waste disposal rates. This study found that retailers with grinders dispose only 0.94 tons of food waste per employee per year. Stores without grinders disposed of 2.53 tons of food per employee per year. The difference between these two disposal rates is assumed to be the amount disposed through grinders. Therefore, the estimated grinder disposal rate is 1.59 tons per employee per year. Again, data from the *Seattle Food Waste Collection and Composting Demonstration Project's* random survey⁹ indicates that 14% of food wholesale/retail businesses use grinders. The product of these two, 14% * 1.59 or .223 tons per employee per year serves as the waste loading factor for the food wholesale/retail sector.

Food Processors

While food processors generate significant quantities of food waste, most food processors do not grind their food. A random survey¹⁰ of 24 food processors found that only 14% dispose of their waste through grinders. According to the same survey, processors generate 19.29 tons of food waste per employee per year. However, those processors using grinders dispose less than 50% of food waste in grinders. A mid-range of 25% is used as a "capture rate". This "capture rate" yields .675 tons of food waste disposed through grinders per employee each year (14% * 28% * 19.29 tons/employee/year).

The calculations described in the previous sections are summarized in the following table:

Table 2.3.2 - Food Waste Loading Factor Scenario Assumptions				
	Base Waste Loadings			
	Food Waste Generation Rate	% with food grinders	% disposed in grinder	Food Waste Loading Factor
	(1)	(2)	(3)	(1)*(2)*(3)
Residential - East Div.	0.071 tns/cap/yr	84%	35%	0.021
Residential - West Div.	0.071 tns/cap/yr	63%	35%	0.016
Food Processors	19.29 tns/emp/yr	14%	25%	0.675
Whlse/Retail	2.53 tns/emp/yr	14%	63%	0.223
Food Service	1.7 tns.emp/yr	47%	57%	0.458

2.3.3 Estimated Current Food Waste Discharge to Sewer System

The following table presents the estimated food waste being discharged to the sewer system with the current management programs which do little to influence behavior with regard to food grinder usage.

Table 2.3.3 - Food Waste Loadings for METRO East and West Divisions 1990-2010			
	Wet tons/person/yr	Wet lbs/person/day	Dry lbs/person/day
Residential - East Division (per capita)	0.021	0.115	0.029
Residential - West Division (per capita)	0.016	0.086	0.022
Food Processors (per employee)	0.675	3.699	0.925
Wholesale/Retail (per employee)	0.223	1.220	0.305
Food Service (per employee)	0.458	2.511	0.628

This table presents both the annual wet tons per capita and the daily wet and dry pounds. Based on research conducted as part of the *Seattle/King County Food Waste Collection Feasibility Study* each wet ton yields approximately 0.25 dry tons of solids if the water was removed.

2.3.4 Estimated Food Waste Discharge for Alternative Management Approaches

Two alternative diversion estimates were developed to identify the potential impact of new solid waste management programs, policies and pricing incentives. The objective of this analysis was to estimate the reasonable limits for sewer discharges of food waste resulting from changes in the incidence and usage of food grinders.

Table 2.3.4.1 identifies a number of programs and policies that could potentially affect the ownership and use of grinders and the impact on food waste discharge.

Table 2.3.4.1 - Food Waste Management Program Assumptions		
Factors Affecting Usage	High Diversion to Grinders	High Diversion Away From Grinders
1. Availability of Alternative Disposal Options a. residential curbside collection b. residential backyard program c. commercial collection d. commercial onsite	No program No program No Program No Program	Program results in less grinder use Program results in less grinder use Program results in less grinder use Program results in less grinder use
2. Education Programs	Education encourages grinder use	Education discourages grinder use
3. Regulations re: Disposal/Grinder Use	Regulations discouraged food waste in garbage	Regulations discouraged food grinder use
4. Pricing Incentives/\$ Penalties	Encourage grinder use	Discourage grinder use
5. Retrofit Programs a. provide grinder units b. buy back grinder units	Increases grinder use N/A	N/A Reduces grinder use

As a means of bracketing the potential changes in behavior that determine the amount of food waste discharged to the sewer system, two conditions representing high diversion to, and high diversion away from grinders have been developed. The assumptions under each situation are based on turning a variety of programs and policies "on" and "off". In all cases, it is assumed that the programs, regulations and incentives are structured in an effective manner, i.e., they will have the desired effect. For example, it is assumed that financial incentives will be significant enough to either divert food waste to or away from grinders and result in the installation, or removal of grinders. These changes in the use and ownership of grinders will dramatically affect food waste loading in the Metro system.

The high loading condition assumes that a combination of education, regulations and pricing incentives and the possible implementation of retrofit programs will drive up the use of grinder units. Under this scenario, residential "capture rates" will increase to 65% (80% of residences disposing 80% of the generated food waste). This approaches a doubling of the 35% capture rate assumed under the base case scenario. The incidence of grinders remains constant. For commercial generators the "capture rate" remains constant, but the number of businesses installing and using grinders increases to 65%; (we assume that increases will lead to installation of new grinders rather than to an increase in the use of existing grinders). Food generation per person or employee are assumed to remain constant through the year 2000.

The low loading condition assumes that a combination of collection programs, along with education, pricing incentives and, if necessary, regulations will drive down the use of food grinders. Under this scenario, residential capture rates are reduced to 5% (20% of residences

discharging 20% of food waste to the system). Again, commercial capture rates remain constant, but use of grinders is also reduced to 5% (i.e., fewer businesses are using grinders, but those choosing to continue to divert food waste through grinders do so at previously documented levels).

The calculations used to develop the food waste loading factors are described in Table 2.3.4.2.

Table 2.3.4.2				
High Sewer System Discharge				
	Food Waste Generation Rate (1)	% with food grinders (2)	% disposed in grinder (3)	Food Waste Loading Factor (1)*(2)*(3)
Residential - East Div.	0.071 tns/cap/yr	84%	65%	0.039
Residential - West Div.	0.071 tns/cap/yr	63%	65%	0.029
Food Processors	19.29 tns/emp/yr	65%	25%	3.135
Whlsc/Retail	2.53 tns/emp/yr	65%	63%	1.034
Food Service	1.7 tns/emp/yr	65%	57%	0.634
Low Sewer System Discharge				
	Food Waste Generation Rate (1)	% with food grinders (2)	% disposed in grinder (3)	Food Waste Loading Factor (1)*(2)*(3)
Residential - East Div.	0.071 tns/cap/yr	84%	5%	0.003
Residential - West Div.	0.071 tns/cap/yr	63%	5%	0.002
Food Processors	19.29 tns/emp/yr	5%	25%	0.241
Whlsc/Retail	2.53 tns/emp/yr	5%	63%	0.080
Food Service	1.7 tns/emp/yr	5%	57%	0.049

Note: % capture (3) for food processors, wholesale/retail, and food service for both high and low loadings are derived from grinder disposal rates as reported in *City of Seattle's Food Waste Collection and Composting Demonstration Project*

The result of these assumptions are much higher or lower food waste loading factors. The loading factors are presented in Table 2.3.4.3.

Table 2.3.4.3 - Estimated Food Waste Loading Factors 1990-2010			
Current Management Conditions	Wet tons/unit/yr	Wet lbs/unit/day	Dry lbs/unit/day
Residential - East Division (per capita)	0.021	0.115	0.029
Residential - West Division (per capita)	0.016	0.086	0.022
Food Processors (per employee)	0.675	3.699	0.925
Wholesale/Retail (per employee)	0.223	1.220	0.305
Food Service (per employee)	0.458	2.511	0.628
High Sewer System Discharge	Wet tons/unit/yr	Wet lbs/unit/day	Dry lbs/unit/day
Residential - East Division (per capita)	0.039	0.213	0.053
Residential - West Division (per capita)	0.029	0.160	0.040
Food Processors (per employee)	3.135	17.176	4.294
Wholesale/Retail (per employee)	1.034	5.663	1.416
Food Service (per employee)	0.634	3.473	0.868
Low Sewer System Discharge	Wet tons/unit/yr	Wet lbs/unit/day	Dry lbs/unit/day
Residential - East Division (per capita)	0.003	0.016	0.004
Residential - West Division (per capita)	0.002	0.012	0.003
Food Processors (per employee)	0.214	1.321	0.330
Wholesale/Retail (per employee)	0.080	0.436	0.109
Food Service (per employee)	0.049	0.267	0.067

2.4 Food Waste Generation and Discharge to the Metro System

The basis for estimating the generation and discharge of food waste to the Metro sewer system have been provided in proceeding sections of the report. These estimates are based on multiple assumptions that in some case have little basis in documented data. The resulting information is suitable for program planning and identifying potentially feasible methods for managing food waste. In general, however, additional information is needed before major implementation decisions can be made.

The following discussion provides the estimates of food waste generation and discharge to Metro's system that have been used to evaluate alternative food waste management approaches.

2.4.1 Food Waste Generation

Table 2.4.1 provides an estimate of the food waste generated within the East and West division service areas in 1990 and 2000. The amount of food processing waste that has historically not been included in food waste generation estimates has also been provided.

Table 2.4.1					
Food Waste Generation Projections for the Years 1990 and 2000					
	Population or Employment			Generation	
			<i>wet tons/person/yr</i>	<i>wet tons per year</i>	
East Division	1990	2000		1990	2000
Residential	434,330	529,935	0.07	30,837	37,625
Food Processors	1,720	1,843	19.29	33,179	35,551
Food Wholesale / Retail	6,721	8,514	2.53	17,004	21,540
Food Services	12,714	16,105	1.70	21,614	27,379
<i>Total Commercial</i>				71,797	84,470
Total East				102,634	122,096
West Division					
Residential	723,894	829,865	0.07	51,396	58,920
Food Processors	6,690	7,167	19.29	129,050	138,251
Food Wholesale / Retail	14,567	18,453	2.53	36,855	46,686
Food Services	29,457	37,316	1.70	50,077	63,437
<i>Total Commercial</i>				215,982	248,375
Total West				267,378	307,295
Total Generation				370,012	429,391
Generation w/o Food Processors			Total	207,783	255,588
			East	72,773	90,099
			West	138,328	169,044
Generation w/o 90% of Food Processors			Total	224,006	272,968
			East	72,773	90,099
			West	151,233	182,869
90% of Food Processors				146,006	156,423
(Estimated Fraction that is Rendered or Reused)					

As a comparison, the solid waste and food waste generation estimates by the local solid waste utilities are also provided on Table 2.4.2.

Table 2.4.2 - Year 1992/3 Solid Waste and Food Waste Generation Estimates			
	<i>Total Solid Waste Wet Tons / yr</i>	<i>Food Waste¹ Wet Tons / Yr</i>	<i>Percent Food Waste</i>
Seattle ²			
Residential	264,300	33,000	12.5%
Commercial	361,800	43,000	11.9%
Sub-Total	626,100	76,000	12.1%
King County ³			
Residential	509,500 ³	81,500 ^{3,4}	16% ^{4 (avg)}
Commercial	345,200 ³	44,900 ^{3,4}	13% ^{4 (avg)}
Sub-Total	854,600	126,400	14.8%
Total	1,480,700	202,400	13.7%

¹ Does not include reused or sewer system discharged food processing waste, only what is landfilled

² Recycling Potential Assessment 1994, Vol. 2, May, 1994, Seattle Solid Waste utility

³ Final 1992 Comprehensive Solid Waste Management Plan Technical Appendices, Aug. 1993, King County Solid Waste Division

⁴ Average fractions from Final Report: Comprehensive Waste Stream Characterization, Cascadia Consulting Group, Inc., Nov. 1994

These estimate are based on composition studies in which solid waste samples are physically sorted into categories and weighed. One of these categories is food waste. This fraction has historically been underestimated because some of the food waste loses water to other fractions and also becomes adhered to other materials. This explains why the generation estimates in this report are higher than those developed by the solid waste utilities. The utility data also does not include food waste discharged to the sewer system or food processing waste that is reused or rendered.

2.4.2 Food Waste Discharge to the Sewer System

Table 2.4.2.1 provides the annual loadings in wet tons for the West and East Division Service Areas.

Table 2.4.2.1 Waste Loading Estimates (Wet Tons)

Current Condition Sector	1990			2000			2010		
	West	East	Total	West	East	Total	West	East	Total
Residential	11,415	9,090	20,504	13,127	11,086	24,213	15,170	12,708	27,878
Food Processors	4,516	1,161	5,678	4,839	1,244	6,083	5,185	1,333	6,518
Whlse/Retail	3,243	1,496	4,739	4,108	1,895	6,003	5,203	2,401	7,604
Food Services	13,499	5,826	19,325	17,100	7,380	24,480	21,662	9,349	31,011
Total	32,673	17,573	50,246	39,174	21,605	60,779	47,220	25,791	73,011
High Sewer Discharge Sector	1990			2000			2010		
	West	East	Total	West	East	Total	West	East	Total
Residential	21,198	16,881	38,079	24,380	20,587	44,967	28,173	23,600	51,773
Food Processors	20,969	5,392	26,361	22,467	5,777	28,244	24,071	6,189	30,260
Whlse/Retail	15,055	6,946	22,001	19,071	8,800	27,871	24,159	11,147	35,306
Food Services	18,669	8,057	26,726	23,649	10,207	33,856	29,958	12,930	42,887
Total	75,891	37,276	113,167	89,567	45,371	134,938	106,361	53,866	160,226
Low Sewer Discharge Sector	1990			2000			2010		
	West	East	Total	West	East	Total	West	East	Total
Residential	1,631	1,299	2,929	1,875	1,584	3,459	2,167	1,815	3,983
Food Processors	1,613	415	2,028	1,728	444	2,173	1,852	476	2,328
Whlse/Retail	1,158	534	1,692	1,467	677	2,144	1,858	857	2,716
Food Services	1,436	620	2,056	1,819	785	2,604	2,304	995	3,299
Total	5,838	2,868	8,705	6,889	3,490	10,380	8,181	4,143	12,326

The preceding table demonstrates that about 40% of the food waste in the system comes from the residential sector. Over 20,000 wet tons of the 50,000 total wet tons in 1990 is contributed by the residential sector.

Table 2.4.2.2 provides a comparison of the quantities of food waste discharged to the sewer system and the total food waste generated. These results indicate that most of the food waste can be diverted away from the sewer system but less than a third is likely to go to the sewers.

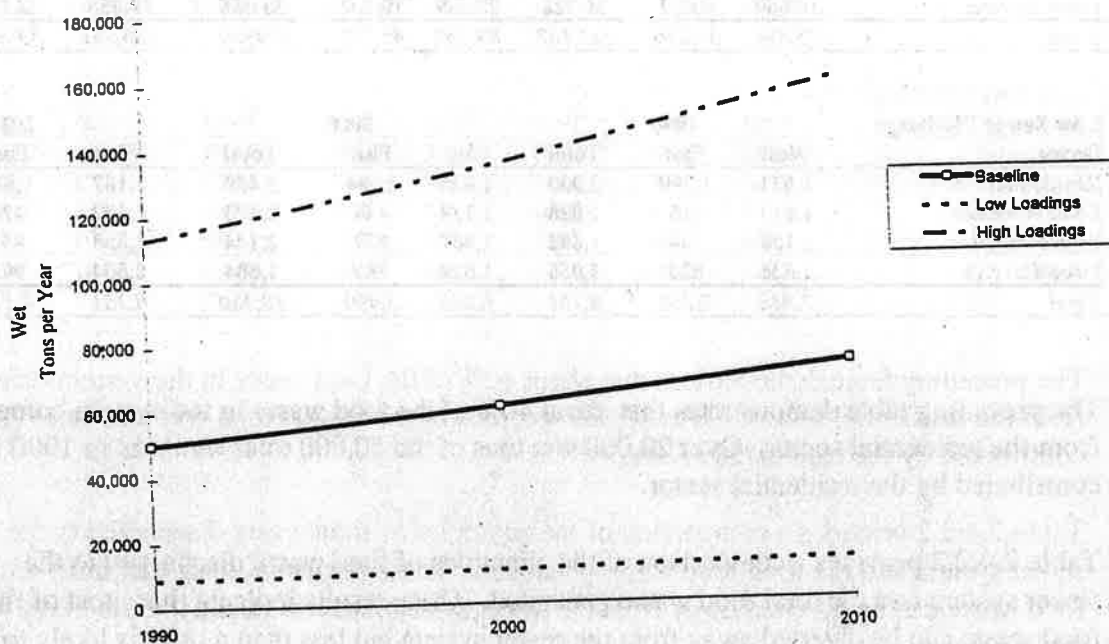
Table 2.4.2.2 - Food Waste Generation and Discharge (Wet Tons)

Service Area	Current Conditions		High Sewer Discharge		Low Sewer Discharge	
	1990	2000	1990	2000	1990	2000
Metro West Division	32,672	39,174	75,891	89,566	5,838	6,890
Metro East Division	17,573	21,605	37,276	45,370	2,867	3,490
Metro System Total	50,246	60,779	113,168	134,937	8,705	10,380
Total FW Generation	370,000	430,000	370,000	430,000	370,000	430,000
Percent FW to Sewers	14%	14%	31%	31%	2%	2%

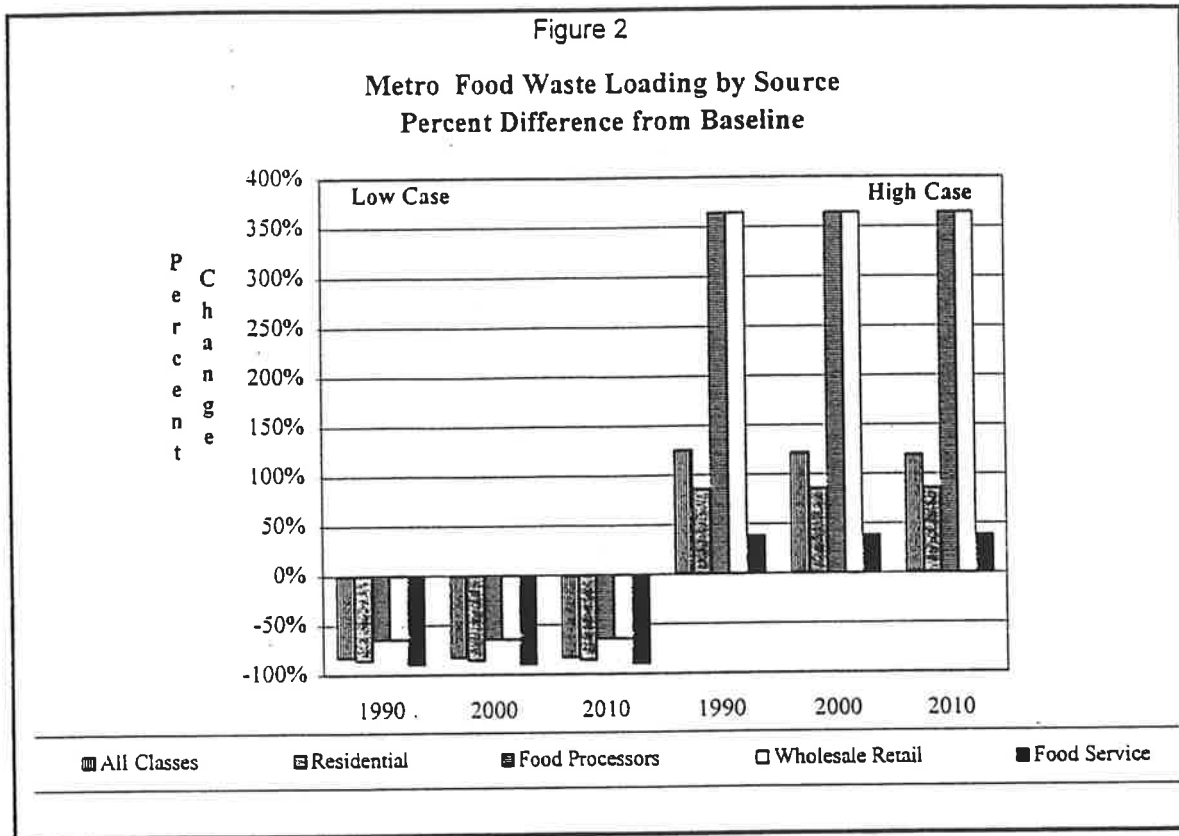
Figures 2.4.2.1 and 2.4.2.2 present the sewer system loadings and loading estimates by sector or source, summarized for the Metro system. The sectors are shown on Figure 2.4.2.2 as percent differences from the base case forecast for the low loading and the high loading scenarios. The dark bar indicates the total loading differences, while the patterned bars depict the differences by source.

Figure 1

Metro System Food Waste Loadings: Base Case and High and Low Scenarios



Scenario	1990	2000	2010	1990	2000	2010
Baseline	50,000	65,000	80,000	50,000	65,000	80,000
Low Loadings	10,000	12,000	18,000	10,000	12,000	18,000
High Loadings	110,000	135,000	165,000	110,000	135,000	165,000



The largest changes occur in the high loading scenario where loadings up to 350% higher are possible. These large changes occur in the food processing and food wholesale/retail sectors. The largest impact for these sectors also occurs in the West Division Service Area due to the concentration of these generators in the western portion of King County.

Table 2.4.2.3 presents the summary numbers for the loading estimates by service area, as deviations for each waste loading scenario from the base case forecast.

Table 2.4.2.3 - Scenario Waste Loading Summary: Pct. Diff. from Base Case						
	Low Waste Loadings			High Waste Loadings		
Service Area	1990	2000	2010	1990	2000	2010
Metro West Division	-82.13%	-82.41%	-82.67%	132.28%	128.64%	125.25%
Metro East Division	-83.68%	-83.85%	-83.93%	112.12%	108.86%	108.86%
Metro System Total	-82.67%	-82.92%	-83.12%	125.21%	122.01%	119.46%

Section 3

Treatment Plant Loading and Impacts

3.1 Treatment Plant Loading

Food waste that is discharged to the sewer system is first ground and then flows many miles in gravity sewers and in many cases through pumps and force mains. The objective of this section is to evaluate the effect of food waste loading on critical process units at the treatment plant. To do this, a literature search was conducted and then food samples were collected and analyzed by Metro using a procedure designed to model conditions of travel through the sewer system. The detailed discussion of these evaluations is included as Appendix B.

The base finding of this analysis is that each ton of food waste discharged to the sewer system results in the load on the treatment process units shown in Table 3.1.1

Table 3.1.1 - Conversion of Food Waste Discharge to Treatment Plant Loading			
	Tons Wet Weight	Tons Dry Weight	Pounds Dry Weight
Food Waste Discharge	1	0.25	500
Process Unit Loading			
Primary Clarifier TS			285
Primary Clarifier VS			235
Aeration Basin BOD			215

The estimated loading on the treatment process units is determined using the food waste quantities discharges to the sewer system developed in Section 2 and the loading fractionation factors from Table 3.1.1. Estimates of the food waste discharged to the sewer system have been developed in previous sections for three separate conditions; 1) a base case that is considered to be a reasonable estimate of current conditions, 2) (high) a reasonable estimate of the maximum discharge and 3) (min) a reasonable estimate of the minimum discharge. For each of these conditions, the food waste discharge was estimated for the West Point and East Division service areas for the years of 1990, 2000 and 2010.

Current Practice Continued - The base case represents the estimate for current food disposal to the sewer system and projections for continuation of the same diversion rates through the year 2010.

Maximum Diversion to Sewer System - This estimate represents the maximum reasonable expected diversion of food disposal waste to the sewer system and projections for continuation of the same diversion rates through the year 2010. An additional analysis was done to show the potential impact of food processing waste on treatment plant loadings. The results indicate that the food processing is a very large potential source of added loading to the treatment facilities. The significance of this cannot be adequately addressed without a more complete analysis of the major sources in this category.

Maximum Diversion to Solid Waste Collection - This estimate represents the minimum reasonably expected diversion of food disposal waste to the sewer system and projections for continuation of the same diversion rates through the year 2010.

Food waste flow and loading estimates to WPTP and EDRP are summarized on Table 3.1.2. The flow projections are based on a literature value of 10-20 gallons of flow per dry pound (gpp) of food waste (based on 1-2 gpcd of 0.5 wet ppcd @ 25% solids). For this analysis 10 gpp was used for the low estimate, 15 gpp for the base case and 20 gpp for the maximum estimate.

Table 3.1.2 - Summary of Food Waste Loading (In lbs per day - Dry Weight or MGD)						
Sewer Discharge Condition	West Point Treatment Plant			East Division Reclamation Plant		
	<i>Flow (MGD)</i>	<i>Primary VS ppd - Dry Wt</i>	<i>Secondary BOD Load ppd - Dry Wt</i>	<i>Flow (MGD)</i>	<i>Primary VS ppd - Dry Wt</i>	<i>Secondary BOD Load ppd - Dry Wt</i>
1990						
Current Case	0.4	18,700	17,100	0.2	10,600	9,700
Maximum	0.8	36,200	33,100	0.4	20,400	18,700
Minimum	0.1	6,500	6,000	0.1	3,200	2,900
1995						
Current Case	0.5	20,500	18,700	0.3	11,900	10,900
Maximum	0.9	39,700	36,300	0.5	22,800	20,900
Minimum	0.2	7,300	6,700	0.1	3,600	3,300
2000						
Current Case	0.5	22,200	20,300	0.3	13,100	12,000
Maximum	0.9	43,100	39,400	0.5	25,200	23,000
Minimum	0.2	8,000	7,400	0.1	4,000	3,700
2005						
Current Case	0.6	24,500	22,400	0.3	14,400	13,200
Maximum	1.0	47,600	43,500	0.6	27,700	25,300
Minimum	0.2	9,000	8,300	0.1	4,500	4,100
2010						
Current Case	0.6	26,700	24,400	0.3	15,600	14,300
Maximum	1.1	52,000	47,600	0.6	30,100	27,500
Minimum	0.2	10,000	9,100	0.1	4,900	4,500

3.2 Food Waste Impacts Upon Solids Production

This section depicts the impacts of treating food waste at Metro's East Division Reclamation Plant (EDRP) and West Point Treatment Plant (WPTP). Food waste loading impacts examined in this report include biosolids production, treatment and product reuse costs, process capacity and treatment requirements. Influent parameters for Total Solids (TS), Volatile Solids (VS) and Biochemical Oxygen Demand (BOD) were utilized in compiling this impact analysis. Four scenarios were examined:

- 1) (min) - the amount of food waste that could be expected with an aggressive management program to discourage the use of food waste grinders
- 2) (base) - the amount of food waste estimated for current management approach
- 3) (hi) - the amount of food waste that could be expected with an aggressive management program that encourages food waste grinding excluding food processing
- 4) (hi w/FP) - the same as 3) above except including food processors

The years 1990, 2000, and 2010 were analyzed in order to insure uniformity with Metro's Wastewater 2020 projections. In 1994, WPTP operated at 95 million gallons per day (MGD) flow, with 219 milligrams per liter (mg/l) TSS and 183 mg/l BOD¹¹. In 1994, EDRP operated at 58 MGD flow, with 256 mg/l TSS and 254 mg/l BOD.

This section consists of four parts: Loading Data, Solids Production, Treatment Costs and Capacity Impacts. The Loading Data section illustrates the amounts of TS, VS and BOD, (as developed within tasks 3.1 & 3.2), which can be anticipated at Metro facilities as a result of food waste loadings within the East and West Divisions. The Solids Production section analyzes what amounts of raw and digested solids which will be produced as a result of projected TS, VS and BOD loading upon the primary and secondary treatment processes at EDRP and WPTP. Operational and maintenance costs associated with this solids production are developed for both EDRP and WPTP within the Treatment Costs section. Finally, the Capacity Impacts section projects what amount of the total facilities at EDRP and WPTP will be dedicated to treating food waste under the different loading scenarios. Conservative estimates are utilized throughout this analysis. Due to space limitations, only the Base Case 1990 scenario is depicted in detail. Similar methodology as is depicted herein was utilized for the remaining scenarios, and summary data for all scenarios is presented at the end of each section.

3.2.1 Loading Data

The loading data in Table 3.2.1 are utilized as the basis for this analysis. This data represents the amounts of TS, VS and BOD which can be expected at WPTP and EDRP

resulting from projected food waste loadings in 1990, 2000 and 2010 under the four different loading scenarios as stated above.

Table 3.2.1 Food Waste Loading to Metro Facilities				
		TS	VS	BOD
		Dry #/d	Dry #/d	#/d
Min - 1990	WPTP	3389	2794	2556
	EDRP	1962	1590	1454
Min - 2000	WPTP	4038	3329	3046
	EDRP	2417	1959	1792
Min - 2010	WPTP	4876	4021	3679
	EDRP	2892	2344	2144
Base - 1990	WPTP	22618	18650	17063
	EDRP	13133	10642	9736
Base - 2000	WPTP	26865	22152	20267
	EDRP	16158	13094	11979
Base - 2010	WPTP	32362	26684	24413
	EDRP	19279	15623	14293
Hi -1990	WPTP	44060	36330	33238
	EDRP	25506	20688	18909
Hi -2000	WPTP	52495	43286	39602
	EDRP	31423	25464	23297
Hi -2010	WPTP	63400	52277	47828
	EDRP	37597	30466	27873
Hi w/FP - 1990	WPTP	60433	49831	45590
	EDRP	29790	24140	22086
Hi w/FP - 2000	WPTP	70038	57751	52836
	EDRP	36013	29183	26699
Hi w/FP - 2010	WPTP	82195	67775	62007
	EDRP	42514	34451	31519

3.2.2 Unprocessed Wastewater Solids Production

The first phase of this analysis estimated the amount of wastewater solids produced as a result of the TS and BOD loading from food waste. All BOD loadings used in this analysis represent levels for secondary influent BOD and assume approximately 57% of the total BOD from food waste will be removed in the primary clarifiers. This percentage was determined from laboratory analysis of properties of ground food waste in Appendix B of this study. This analysis assumed 0.88 lbs waste activated sludge will result from 1 lb. BOD loading. Each scenario for min, base, max and max w/FP was examined for the years 1990, 2000 and 2010 for this analysis, though only the base case for 1990 is presented in detail in this report. All analyses for other years and scenarios follow the same methodology. Summary data for all scenarios is presented at the end of each section.

From the influent loading analysis, the data from base case 1990 is selected and presented in Table 3.2.2 in units of dry pounds per day (dry #/d) or pounds per day (#/d). The volatile solids content of the food waste stream is determined to be 81% for WPTP.

Table 3.2.2.1 1990 Base Case Loading Data						
Treatment Facility	TS (Primary)		VS (Primary)		BOD (Secondary Influent)	
	(dry #/d)	(Dtn/y)	(dry #/d)	(Dtn/y)	(#/d)	(Tn/y)
WPTP	22618	4128	18650	3404	17063	3114
EDRP	13133	2397	10642	1942	9736	1777

Total solids produced at the treatment plant as a result of the food waste loading are computed in dry tons per year (Dtn/yr) as the sum of the primary solids settled out in the primary clarifiers and the secondary activated solids produced from secondary influent BOD to the aeration basins. The fractionation of food waste between the primary and secondary treatment processes is presented in Appendix B. This analysis assumed 0.88 pound of secondary solids were produced per pound of secondary influent BOD¹¹ with a volatile solids content of 81%.

Table 3.2.2.2 Raw Solids Produced at Treatment Plants, Base Case 1990						
	Primary TS	Secondary BOD load	lb SS/lb BOD	Secondary TS	Total Raw Solids (Primary & Secondary)	
	(Dtn/yr)	(Tn/yr)		(Dtn/yr)	(Dtn/yr)	(dry #/d)
WPTP	4128	3114	0.88	2740	6868	37633
EDRP	2397	1777	0.88	1564	3960	21701
Total					10828	59334

Solids production from food waste loadings was projected for Low, Base Case, High and High w/FP in the three model years using a similar calculation. The complete raw primary and secondary solids generation matrix is depicted in Table 3.2.4.

Table 3.2.4 - Summary of Raw Primary & Waste Activated Solids Production From Food Waste					
Year	Treatment Facility	Raw Solids - Low	Raw Solids - Base	Raw Solids-High	Raw Solids-High w/FP
		(Dtn/yr)	(Dtn/yr)	(Dtn/yr)	(Dtn/yr)
1990	WTP	1029	6868	13379	18351
	EDRP	592	3960	7692	8984
	Total	1621	10828	21071	27334
2000	WTP	1226	8158	15940	21267
	EDRP	729	4873	9476	10860
	Total	1955	13030	25417	32128
2010	WTP	1481	9827	19252	24959
	EDRP	872	5814	11338	12821
	Total	2353	15641	30590	37780

The raw solids produced as a result of food waste must be processed within digesters to reduce the volume and stabilize the solids until suitable for reuse. The following section depicts the reduction in volume which occurs as a result of solids digestion.

3.2.3 Digested Solids Production

Table 3.2.3.1 presents the amount of dry digested solids produced at Metro facilities as a result of food waste loadings under each of the four scenarios. This analysis assumes secondary treatment at WTP. These figures assume 81% volatile solids in food waste and that the digesters attain 59% volatile solids reduction¹².

Table 3.2.3.1 - Dry, Digested Biosolids Production from Food Waste Loadings					
Year	Treatment Facility	Digested Solids - Low	Digested Solids - Base	Digested Solids-High	Digested Solids-High w/FP
		(Dtn/yr)	(Dtn/yr)	(Dtn/yr)	(Dtn/yr)
1990	WTP	537	3,586	6,985	9,581
	EDRP	309	2,068	4,016	4,690
	Total	846	5,654	11,001	14,271
2000	WTP	640	4,259	8,322	11,104
	EDRP	381	2,544	4,948	5,670
	Total	1,021	6,803	13,270	16,774
2010	WTP	773	5,131	10,051	13,031
	EDRP	455	3,035	5,919	6,694
	Total	1,228	8,166	15,971	19,725

Table 3.2.3.2 contrasts biosolids produced as a result of food waste loading in the Base Case with total biosolids production projections for WPTP and EDRP¹³. The total biosolids production figures assume that PCL/SMI receives none of the raw sludge produced at WPTP. 1996 was used as the initial model year as this is the first full year the WPTP will be producing secondary biosolids. As biosolids generation predictions from food waste assume secondary treatment, comparisons of biosolids generation data before 1996 would be non-relevant for WPTP. For comparative purposes, this analysis examines solids production figures assuming that PCL/SMI accepts none of WPTP raw solids.

Table 3.2.3.2 - Percentage of Biosolids from Food Waste Under the Base Case Scenario						
Year	Biosolids Production from Food Waste		Total Biosolids Production ¹⁴		Percentage of Total Biosolids Production from Food Waste	
	(Dtn / yr)		(Dtn / yr)		(%)	
	WPTP	EDRP	WPTP	EDRP	WPTP	EDRP
1996	3989	2353	20749	14731	19%	16%
2000	4259	2544	22271	15692	19%	16%
2010	5131	3035	24636	17630	21%	17%

The percentages of biosolids attributable to food waste differ slightly from the percentages of food waste loading compared to total influent projections as developed previously. These differences are minor (+/- 2%) and represent the difference between source data sets used for the individual analyses. Wastewater 2020 data was utilized for influent loading projections and Biosolids Program long-range production planning data was utilized to develop Table 3.2.3.2.

3.3 Cost of Treating Food Waste

Several types of operational costs are incurred through the processing of solids and BOD in municipal wastewater plants. The costs addressed here include aeration, solids processing and application costs. Aeration costs are developed from historical operating costs for the aeration system at EDRP and are portrayed in a cost per pound BOD (\$/# BOD). Solids processing and application costs are portrayed in a cost per dry ton format (\$/Dtn) or cost per ton (\$/Tn) as developed by Metro's Biosolids Strategic Long-Range Plan.

3.3.1 Aeration

Addition of air in the aeration basins converts the secondary influent BOD to waste activated sludge which will settle out in the secondary clarifiers. In order to compute aeration costs for the secondary influent load attributed to food waste, a cost per pound of BOD influent was derived from historical operational data from the East Division

Reclamation Plant. Table 3.3.1.1 multiplies the pounds per year BOD loading of food waste by the historical aeration costs per pound BOD to derive an annual aeration cost. Aeration costs for WPTP's High Purity Oxygen aeration system will most likely be higher than EDRP's aeration costs, but since the aeration system at WPTP is not yet operational, this analysis assumes that aeration costs will be the same for both facilities.

Table 3.3.1.1 - Aeration Costs for 1990 Base Case				
				Cost =
Aeration Costs ¹⁶	f ³ air/# BOD	kwh/f ³ air	\$/kwh	\$/# BOD
	1079	0.000557	0.036	0.022
Annual Costs				
	Loading	Aeration Cost	Total Cost	
	(# BOD/yr)	(\$/# BOD)	\$/yr	
West Point	6227995	\$0.022	\$134,750	
Renton	3553640	\$0.022	\$76,887	

This analysis was repeated to develop aeration costs which are incorporated for each of the scenarios as illustrated in Appendix C, "FW Cost - Mid 1990."

3.3.2 Solids Processing and Application Costs

Solids processing costs are incurred from thickening, anaerobic digestion, dewatering and drying (at WPTP) the solids entering the wastewater treatment plants. Application costs vary according to the reuse option selected. Costs developed as a part of the Biosolids Strategic Long-Range Plan were utilized as a basis for this analysis and are given on Table 3.3.2.1. The costs for drying were modified to represent raw tons and haul and application costs were inflated to properly represent costs per dry tons. Aeration costs were included as a separate column within the base processing costs. This analysis assumes a 59% volatile solids reduction due to digestion and dewatering to 19% solids content. Raw solids represent total both raw primary sludge and waste activated sludge resulting from food waste loadings. This method results in conservative loading and cost calculations for individual treatment plant processes. For simplicity, this analysis assumed PCL/SMI would accept 55% of total combined raw and waste sludge. Actual contract conditions bind PCL/SMI to accept up to 60 dry tons per day.

3.3.3 Cost Summary

An analysis identical to that depicted in Table 3.3.2.1 was performed for each scenario and analysis year to derive projected operational costs as illustrated in Table 3.3.31. These costs will not represent avoided costs associated with food waste treatment, but only indicate the magnitude of operational costs incurred. Costs are in 1994 dollars.

Table 3.3.2.1 Estimated Operation Maintenance Costs at Treatment Plants for 1990 Base Case Food Waste Loading

Table 3.3.2.1

Quantity (6)		Base Processing				Reuse Options			TOTAL COST	
		Thickening (1)		Anaerobic Dewatering (1) Aeration (3)		Drying (1,2) (raw)	Compost (1) (digested)	H&A (1,2) Eastern WA		H&A (1,2) Silviculture
Raw	Digested	\$/d tn 29	\$/d tn 15	\$/d tn 51	\$ /# BOD 0.022	\$/d tn 278	\$/d tn 184	\$/wtn 33 \$/d tn 174		\$/wtn 20 \$/d tn 105
Product Description		%								
WPTP			6868	1587						
Class B Solids H&A to E. WA H&A to Silviculture	45	1587	\$89,629	\$46,360	\$80,940	\$134,750		\$137,824	\$83,530	
	50	794								
	50	794								
Dried-Raw Solids (PCL/SMII)	55	3777	\$109,546			\$1,050,133				
	100	6868	\$199,175	\$46,360	\$80,940	\$134,750	\$0	\$137,824	\$83,530	
\$1,732,712										
EDRP			3960	2067						
Class B Solids H&A to E. WA H&A to Silviculture Compost	100	2067	\$114,851	\$59,406	\$105,415	\$76,887		\$161,549	\$97,908	
	45	930								
	45	930								
	10	207								
Subtotal		100	3960	2067	\$114,851	\$59,406	\$105,415	\$76,887	\$0	
								\$38,032	\$97,908	
\$654,047										
\$2,386,759										

(1) - Includes operation and maintenance costs from Biosolids Strategic Long-Range Plan

(1) = Includes operation and maintenance costs from processing Strategic Materials.
(2) = Adapted from Biosolids Strategic Long-Range Plan to reflect dry tons

(2) - Adapted from Biosolids Strategic Long-Range Plan to reflect city to
(2) - Finger Dick Memo dated 10/12/94. See Table 3.3.7 for details.
(2) -

(3) - Finger, Dick. Memo dated 10/12/94.

(4) - E&A Technical Memo

(5) - Includes gas revenues.

(6) - Includes primary and waste activated sludges.

(7) - From Table 3.3.1

Food Waste Loadings for 1990 (7)	TS	VS	BOD
	(#/d)	(#/d)	(#/d)
West Point Renton	22618	18650	17063
	13133	10642	9736

Table 3.3.3.1 Operational Costs to Treat Food Waste at Metro Facilities (in millions \$)					
Year	Treatment Facility	Cost - Low	Cost - Base	Cost - High	Cost - High w/FP
		(\$M/yr)	(\$M/yr)	(\$M/yr)	(\$M/yr)
1990	WPTP	\$ 0.3	\$ 1.7	\$ 3.3	\$ 4.6
	Renton	\$ 0.1	\$ 0.6	\$ 1.3	\$ 1.5
	Total	\$ 0.4	\$ 2.4	\$ 4.6	\$ 6.0
2000	WPTP	\$ 0.3	\$ 2.0	\$ 4.0	\$ 5.3
	Renton	\$ 0.1	\$ 0.8	\$ 1.5	\$ 1.8
	Total	\$ 0.4	\$ 2.8	\$ 5.5	\$ 7.1
2010	WPTP	\$ 0.4	\$ 2.5	\$ 4.8	\$ 6.2
	Renton	\$ 0.1	\$ 0.9	\$ 1.8	\$ 2.1
	Total	\$ 0.5	\$ 3.4	\$ 6.7	\$ 8.3

3.4 Treatment Process Capacity Impacts

Any food wastes entering Metro's conveyance and treatment system will occupy a part of the treatment plants' solids and liquids stream capacities. For WPTP, the facility's Design Annual Average loadings were used for all calculations, while 1992 EDRP annual average operating data and interviews with EDRP process staff were utilized for EDRP capacity calculations.

3.4.1 Hydraulic Capacity

Flow estimates indicated that even under the highest conceivable loading conditions with food processors, the total projected waste flow would remain under 1.5 MGD for EDRP and under 2.5 MGD for WPTP. Comprising less than 5% of each facility's total flow, this is insignificant under most operating conditions and is not analyzed further.

3.4.2 Aeration Basin and Digester Capacity

Table 3.4.2.1 projects the percentage of the design loading for aeration basins and digesters which will be occupied by food waste under the different scenarios and model years identified within this report. In this study, design annual average values were utilized as capacity loading rates for the aeration and digestion facilities.

To determine the capacity impacts on the aeration basins, the projected quantities of BOD derived from food waste was compared to the annual average design loading as secondary influent for WPTP and EDRP aeration facilities. To determine the capacity impacts on the

Table 3.4.2.1 Annual Average Treatment Capacity Occupied By Food Waste

Digestion Capacity Occupied by Food Waste Loadings

WPTP Loading Scenario	Model Years					
	1990 (# / day TSS)	1990 % Dig. Load	2000 (# / day TSS)	2000 % Dig. Load	2010 (# / day TSS)	2010 % Dig. Load
Min	3389	1	4038	2	4876	2
Base	22618	10	26865	12	32362	14
Max	44060	19	52495	23	63400	27
Max w/FP	60433	26	70038	30	82195	35

WPTP
Digester Capacity*
(# / day TSS)

233000

(*Design Annual Avg.
WAS + Raw Primary)

EDRP Loading Scenario	Model Years					
	1990 (# / day TSS)	1990 % Dig. Load	2000 (# / day TSS)	2000 % Dig. Load	2010 (# / day TSS)	2010 % Dig. Load
Min	1962	1	2417	1	2892	1
Base	13133	5	16158	6	19279	7
Max	25506	9	31423	11	37597	13
Max w/FP	29790	10	36013	12	42514	15

EDRP
Digester Capacity*
(# / day TSS)

290000

(*Design Annual Avg.
WAS + Raw Primary)

Aeration Basin Capacity Occupied by Food Waste Loadings

WPTP Loading Scenario	Model Years					
	1990 (# / day BOD)	1990 % Aer. Load	2000 (# / day BOD)	2000 % Aer. Load	2010 (# / day BOD)	2010 % Aer. Load
Min	2556	2	3046	3	3679	3
Base	17063	15	20267	18	24413	22
Max	33238	30	39602	36	47828	43
Max w/FP	45590	41	52836	48	62007	56

WPTP
Aeration Capacity**
(# / day BOD)

111000

(**Design Annual Avg.
Secondary Influent)

EDRP Loading Scenario	Model Years					
	1990 (# / day BOD)	1990 % Aer. Load	2000 (# / day BOD)	2000 % Aer. Load	2010 (# / day BOD)	2010 % Aer. Load
Min	1454	1	1792	1	2144	2
Base	9736	8	11979	9	14293	11
Max	18909	15	23297	18	27873	22
Max w/FP	22086	17	26699	21	31519	24

EDRP
Aeration Capacity**
(# / day BOD)

129412

(**Design Annual Avg.
Secondary Influent)

digesters, the projected quantities of TSS derived from food waste was compared to the annual average design loading as combined Waste Activated Sludge (WAS) and Primary Sludge digester feed TSS for WPTP and EDRP digestion facilities. This calculation oversimplifies the complex calculations actually used to design aeration and digestion facilities at treatment plants, but it serves to illustrate the relative loadings to the facilities.

These annual average design loading values were obtained from Renton III design documents and the final design documents for WPTP. Food waste loadings were derived from earlier in Section 3 of this report. It must be noted that when fully operational, PCL/SMI facilities will accept up to 60 dry tons per day of TSS which otherwise would have been loading to WPTP digesters. This will result in a reduction of the food waste loadings to WPTP digesters.

As illustrated in Table 3.4.2.2, the percentage of aeration capacity occupied by food waste is lower than the percentage of total influent BOD for both WPTP and EDRP in the 1990 model year. This difference arises because the flow is not currently approaching design flows for the facilities. Projecting food waste loading to 2010, this differential reduces and the values for capacity and percentage of total flow occupied by food waste become more equal.

Table 3.4.2.2 Comparative Food Waste Loadings to Aeration Process (Base Case)

Model Year	1990		2010	
	% Aeration Capacity occupied by Food Wastes	% Total BOD of Influent from Food Wastes	% Aeration Capacity occupied by Food Wastes	% Total BOD of Influent from Food Wastes
WPTP	15	17	22	23
EDRP	8	15	11	14

3.4.3 Capacity Summary

Base case food waste loadings from the 1990 base case occupy approximately 15% of WPTP's aeration capacity and 10% of digestion capacity as determined by comparison with annual average design loadings. At EDRP, the 1990 projected food waste loads occupy approximately 8% of the aeration capacity and 5% of the digestion capacity as determined by comparison with annual average design loadings.

Under the most extreme conditions of "Maximum with Food Processors" in the year 2010, food waste could occupy 35% of digestion capacity for WPTP and 11-28% of capacity for EDRP.

3.4.4 Secondary Treatment Removal Requirements

NPDES guidelines dictate that effluent discharged from secondary wastewater treatment plants must not exceed 30 mg/l each of TSS and BOD, or represent 85% removal of the influent TSS and BOD concentrations, whichever is most stringent.

The following analysis calculates the BOD and TSS influent concentration levels attributable to food waste under the 1990 base case and illustrates the treatment levels required if food waste was removed from the influent stream. The most recent 1994 annual average influent concentrations for WPTP and EDRP were utilized in this analysis. 1994 annual average flows of 57.9 MGD for EDRP and 94.8 MGD for WPTP were used to develop Tables 3.4.4.1 and 3.4.4.2. Food waste loadings were interpolated for 1994 from Section 3.1¹⁵.

Table 3.4.4.1 - EDRP Influent TSS & BOD Concentrations

	EDRP Influent Conc. ¹⁶	EDRP Food Waste Influent Conc.	Remaining Influent Conc.	Effluent Treatment Levels Required @ 85% Removal
	(mg / l)	(mg / l)	(mg / l)	(mg / l)
TSS	256	25	231	30
BOD	254	34	220	30

Table 3.4.4.2 - WPTP Influent TSS & BOD Concentrations

	WPTP Influent Conc. ¹⁷	WPTP Food Waste Influent Conc.	Remaining Influent Conc.	Effluent Treatment Levels Required @ 85% Removal
	(mg / l)	(mg / l)	(mg / l)	(mg / l)
TSS	219	26	193	29
BOD	183	36	147	22

Removal of all food waste from EDRP's influent stream would not alter the 30/30 treatment requirements. Removal of all food waste from WPTP's influent stream may lower the treatment requirements for both TSS and BOD below the 30/30 monthly permit threshold. The TSS limit for WPTP is currently 27 mg/l. Removing all food waste is estimated to lower this limit to 22 mg/l.

3.5 Food Waste Effects Upon Biosolids

This section outlines possible effects upon biosolids quality from projected food waste loadings to Metro's treatment plants. This analysis also includes potential impacts on Metro biosolids quality if food wastes were absent from the waste stream. The analyses

focus on heavy metals and nutrients, and assumes comparable concentrations of metals and nutrients in residential and commercial food wastes. 1993 was chosen as the model year due to availability of metals and nutrient data for Metro biosolids.

3.5.1 Heavy Metals

Metals concentrations in biosolids are monitored in order to ensure compliance with EPA Code of Federal Regulations for biosolids application (40 CFR 503). EDRP biosolids are examined in this analysis. Though current metals monitoring data indicate higher concentrations of several metals within the WPTP biosolids, it is unknown how these levels will change with secondary treatment. Therefore, metals data for EDRP are used in this analysis (Appendix D).

Levels of metals concentrations in food waste which will be used for this analysis were obtained from a 1994 King County commercial food waste collection and sampling project. As there is no current data available for metals concentrations in residential food waste, it is assumed that these levels are comparable with those found in commercial food waste. The 1994 analysis detected only cadmium, copper, lead and zinc in the commercial food waste at levels above minimum detection limits.

Metro produced 18,800 dry tons of biosolids in 1993, of which EDRP produced 11,700 dry tons¹⁸. For the same year, 2,200 dry tons of biosolids would have been produced at EDRP from food waste¹⁹. This would constitute 19% of EDRP's total 1993 biosolids production. These production rates were utilized to develop the average dry ton per year metals concentrations.

Table 3.5.1.1 presents the percentage of metals detected within EDRP biosolids which can be attributed to food waste. These figures are derived by multiplying the dry mg/kg concentration of metals found in both food waste and EDRP biosolids by the amount dry tons of biosolids for each food waste and total plant production. Though Table 3.5.1.1 illustrates that food waste contributes an insignificant amount to the overall metals loading of EDRP biosolids, the organic solids produced from the food waste will serve to dilute the overall metals content of the biosolids.

Table 3.5.1.2 depicts the increase in metals concentration which may be expected if food waste is removed from EDRP biosolids. Since metals concentrations within food waste are effectively zero, a 19% increase in overall metals concentration can be predicted in the total remaining biosolids if all the biosolids from food waste are removed. The only exception to this is Cadmium, which will only increase 14% because food waste contributes approximately 5% to the total Cadmium load. The resulting metals concentrations are contrasted against EPA limits for "Exceptional Quality Biosolids" to determine whether the resulting product will still qualify under those limits.

Table 3.5.1.1 - Metals Concentration in EDRP Biosolids in 1993

Metal	Food Waste Metals Conc. ²⁰	EDRP Biosolids Metal Conc.	Food Waste Metals Loading	EDRP Biosolids Metal Loading	% Metals from Food Waste
	(dry mg/kg)	(dry mg/kg)	(dry ton/yr)	(dry ton/yr)	(%)
Arsenic		9.1		.106	
Cadmium	2	7.7	.004	.090	4.9 %
Chrome		63		.737	
Copper	18	840	.040	9.828	0.4 %
Lead	1.3	88	.003	1.030	0.3 %
Mercury		0.65		.008	
Molybdenum		12		.140	
Nickel		26		.304	
Selenium		7.4		.087	
Silver		81		.948	
Zinc	53	860	.117	10.062	1.2 %

**Table 3.5.1.2 - Food Waste Effects on 1993 Metals Concentration
@ EDRP**

Metal	Metals Conc. with Food waste	Metals Conc. w/out Food Waste	EPA Exceptional Quality Limits
	(dry mg/kg)	(dry mg/kg)	(dry mg/kg)
Arsenic	9.1	10.8	41
Cadmium*	7.7	8.8	39
Chrome	63.0	75.0	1200
Copper	840.0	999.6	1500
Lead	88.0	104.7	300
Mercury	0.7	0.8	17
Molybdenum	12.0	14.3	n/a
Nickel	26.0	30.9	420
Selenium	7.4	8.8	36
Silver	81.0	96.4	n/a
Zinc	860.0	1023.4	2800

* Cadmium concentration only increases 14% due to 5% concentration in food waste.

The removal of food waste from biosolids at EDRP should not cause any metal concentration (mg/kg) to rise above the levels permitted as "Exceptional Quality" by the EPA 503 regulations.

3.5.2 Nutrients

Nutrient concentrations in biosolids are monitored in order to ensure compliance with EPA Code of Federal Regulations for biosolids application (40 CFR 503.13.) EDRP biosolids are examined in this analysis because it is currently operating at secondary treatment and the corresponding nutrient concentrations have been recorded.

Levels of nutrient concentrations in food waste which will be used for this analysis were obtained from a 1994 King County commercial food waste collection and sampling project. It is assumed that these levels are comparable for both residential and commercial food waste.

Metro produced 18,800 dry tons of biosolids in 1993, of which EDRP produced 11,700 dry tons²¹. For the same year, 2,200 dry tons of biosolids would have been produced at EDRP from food waste. This would constitute 19% of EDRP's total 1993 biosolids production²². These production rates were utilized to develop the average dry ton per year nutrient concentrations.

Table 3.5.2.1 presents the percentage of nutrients detected within EDRP biosolids which can be attributed to food waste. Some amount of the nutrients may be reduced or modified during the wastewater treatment process. However, determining the kinetics for such a reaction is beyond the scope of this project. For this analysis it is assumed that the food waste will maintain its nutrient levels throughout the treatment process.

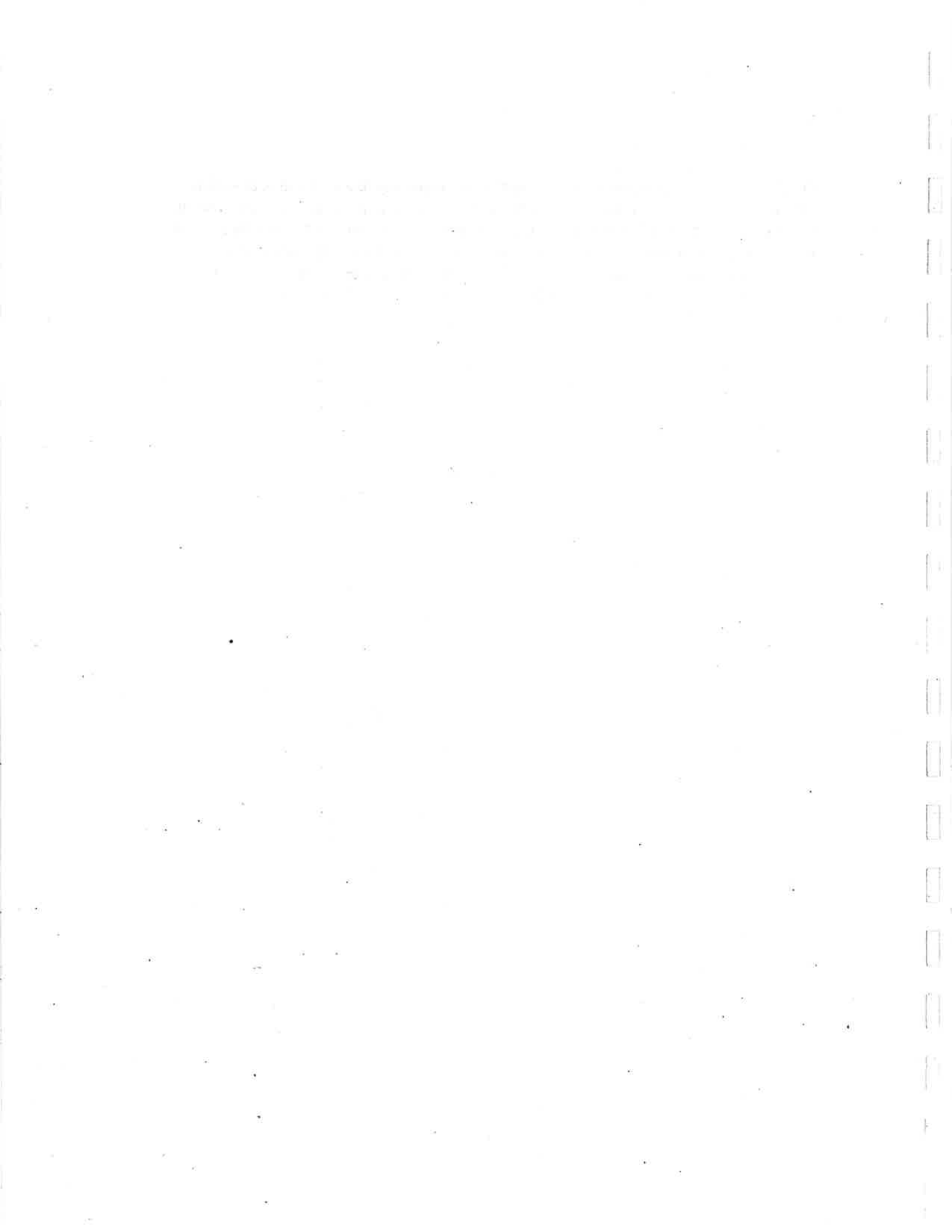
Table 3.5.2.1 - Nutrient Load From Food Waste at WPTP					
Nutrient	Food Waste Nutrient Conc. ²³ (dry mg/kg)	Biosolids Nutrient Conc. ²⁴ (dry mg/kg)	Food Waste Nutrient Loading (dry ton/yr)	Biosolids Nutrient Loading (dry ton/yr)	Nutrients due to Food Waste (%)
Total Phosphorus	3270	27000	7.194	315.9	2%
Organic Nitrogen	31560	54000	69.432	631.8	11%
Ammonia Nitrogen	1040	11000	2.288	128.7	2%

Metro currently applies biosolids according to agronomic rates as determined by crop and specified in CFR 503, typically about 4 dry tons per acre for agricultural applications and about 7 dry tons per acre for silviculture. Food waste contributes to as much as 11% of the Organic Nitrogen levels for biosolids.

3.5.3 Conclusion

Food wastes do not contribute significantly to the metals content of Metro's biosolids. However, this organic stream would serve to dilute the biosolids overall metals content. Elimination of this dilution effect may increase the cumulative metals loading by as much as 19% at application sites. This should have no effect upon EPA permitted levels for "Exceptional Quality" biosolids, though this may shorten the site life as measured by cumulative metals loading. Continued monitoring of site conditions and biosolids metal content would determine the significance of this effect.

Food wastes contribute approximately 11% of the Organic Nitrogen content of Metro's biosolids. Phosphorus and Ammonia Nitrogen from food waste comprise only a fraction of the total concentrations found within EDRP biosolids. Assuming that Organic Nitrogen is the limiting factor in the application of biosolids, removing this nutrient load may affect the agronomic application rates by allowing up to 11% more biosolids to be applied per acre. Minor cost savings may result through reduced application costs. Increased application rates would increase the cumulative metals loading for the site and further reduce site life by an incremental amount.



Section 4

Alternative Analysis and Implementation Recommendations

The objective of the alternative analysis is to develop and evaluate a complete range of alternatives for the control of food waste and to determine how each of these alternatives would affect loading on Metro treatment facilities. The alternatives represent the full range of management methods including: 1) encouraging maximum disposal to the sewer system, 2) source separation, collection and processing into a product and 3) encouraging maximum collection and disposal of food waste with the solid waste stream (garbage collection and landfilling). These alternative concepts are combined to form alternatives which are then evaluated using a matrix approach to identify the several approaches that have the greatest merit for further consideration by Metro. The analysis includes preliminary planning level cost estimates based on costing data from previous studies and historical operating costs for Metro facilities which have been provided by Metro. The result of the analysis will be to refine and limit the management options that have potential for cost effective implementation. However, additional evaluation will be necessary in most cases to justify proceeding with implementation of any of the management alternatives.

The alternative analysis consists of a review of food waste management concepts, development of alternative management programs, comparison of the alternatives and a review of implementation recommendations.

4.1 Alternative Development

The objective of alternative development is to identify alternatives that serve the needs of the community and the agencies that provide food waste management services to that community. Specific benefits to the community that need to be represented in the alternatives include:

- Reduced cost for food waste management
- Reduced risk of illness or disease
- Reduced environmental impacts including maximum recycling of waste materials
- Reduced aesthetic issues such as odors and unsightly facilities
- Reduced impacts at West Point Treatment Plant (facilities, space, truck traffic)

These benefits are the basis for selecting and evaluating the alternatives for this evaluation.

4.1.1 Food Waste Management Concepts

The following review of alternative techniques and programs for controlling food waste disposal to the sewer system includes a description of the techniques and a brief discussion of how they might be used in program implementation. The specific management techniques include:

1. Education programs
2. Sewer discharge limitations or prohibitions
3. Limitation or prohibition of disposal of food waste at public solid waste facilities
4. Rate structures that influence disposal practices
5. Source separation programs
 - separate collection of food waste with soiled paper for composting
 - source separation of food waste only with anaerobic digestion.
 - residential co-collection and co-composting with yard waste.

4.1.1.1 Education Programs

An education program could be used to encourage residential and commercial generators to direct food waste in one of four directions:

1. To the sewer system through a grinder
2. To onsite processing and reuse such as composting or a worm bin
3. To the garbage collection and disposal system
4. To a separate food waste collection system and processing facility

An education program could either encourage or discourage both commercial and residential use of food grinders. The relative environmental and economic costs of the four options would be a focus of the education program.

4.1.1.2 Sewer Discharge Limitations Or Prohibitions

Current limitation on the discharge to the sewer system relative to commercial food waste consist of permitting procedures and surcharges for high strength wastes (BOD

and TSS greater than 300 and 400 mg/L). Some of the sewage collection agencies also require grease traps on restaurants and other grease generating businesses.

Beyond these current constraints several other management methods could be implemented:

1. Prohibition of residential and commercial food waste grinder use
2. Prohibition of food grinder installation in new construction and sales within the service area

It is apparent that these methods could be unpopular if not combined with educational programs to explain the rationale for the action and reasonable options to grinder usage.

4.1.1.3 Limit or prohibit disposal of food waste at public solid waste facilities

Similar management methods are available for controlling the flow of food waste to the solid waste system. These methods could be used to encourage discharge to the sewer system or to onsite or source separated collection and processing programs:

1. Prohibit commercial discharge of food waste to the solid waste management system
2. Prohibit residential and commercial discharge of food waste to the solid waste management system

This type of approach is currently used successfully by the City of Seattle to force yard debris into a separate collection and processing system.

4.1.1.4 Develop rate structures that influence disposal practices (economic incentives)

Because garbage rates are based on can volume, passive incentives are already in place to encourage the use of residential and commercial food waste grinders. Most local haulers offer lower rates for smaller solids waste containers. By disposing of waste down the drain or on site the users now have this option. In addition, grinder use is currently free since there is no difference in fee except as a result of additional water use, energy use and the equipment cost and time required for use.

Encouraging food grinder use and discharge to the sewer would result in higher processing costs incurred at the treatment plant. A rate reduction to encourage grinder use would

therefore be difficult to justify. A possibly feasible method of encouraging use would be providing a subsidy program for installation of food grinders.

4.1.1.5 Source separation programs

Source separation programs require that the generator (whether residential or commercial) keep food waste separate from other wastes until it can be collected or processed. The onsite option involves composting or worm bin processing of the food waste at the residence or business. This would involve low technology processing and use of the product at the generators site and require space at the generator's facility.

If a separate food waste collection is available, the food waste would be transported to centralized processing sites to convert the food waste to compost, energy or other beneficial end products and then transported from the processing site to the reuse site.

Processing Options for Source Separated Food Wastes

Two methods of converting the food waste to an environmentally benign form are composting and anaerobic digestion. Both of these technologies have been demonstrated on a full scale basis. Local composting experience was provided by the Seattle Commercial Food Waste Collection and Composting Demonstration Project. Anaerobic digestion of food processing wastes is relatively common. European experience is available on the anaerobic digestion of source separated food waste.

Food Waste Composting

In this process the collected food waste would be mixed with a bulking material such as shredded yard debris or wood waste and placed in aerated piles. The microbial population present in these materials will rapidly degrade the food waste and will develop a thermophilic environment as a result of release of energy from the degradation process. The food waste will be converted into a stable, rich organic humus material that will have value as a soil amendment.

Food Waste Anaerobic Digestion

The anaerobic digestion process requires an oxygen free environment in which organic compounds are reduced to methane, carbon dioxide and water. The resulting products are recoverable energy from the methane and a solids residual not unlike wastewater biosolids. In order to accomplish anaerobic digestion the food waste must be macerated and moistened to optimize the microbiological activity. A digesting reactor must be provided that will maintain the warm, oxygen free environment necessary for digestion. Following digestion the off gas must be processed in preparation for electricity generation or direct feed to a natural gas system. The residual solids will

most likely need to be dewatered in preparation for hauling to a beneficial use site. This residual is a valuable organic soil conditioner that should be utilized.

Two methods of implementation are available. Food waste could be delivered directly to a waste water treatment facility with anaerobic digestion for direct injection to the anaerobic digesters. Because of the readily degradable character of food waste, the food waste should be efficiently converted to methane and the residual solids will be limited. The net result should be improved performance by the digesters, higher methane production and a higher quality biosolids product.

The second approach is to provide a separate facility to receive and anaerobically digest food waste thereby producing a fuel and an organic soil amendment. Several companies are actively marketing anaerobic digestion technologies for food waste processing in the Seattle area. These companies have expressed interest in developing private facilities to receive and process food waste for a profit.

4.2 Alternative Descriptions

Based on the management concepts discussed above, a series of alternatives have been developed to evaluate the broad spectrum of programmatic alternatives that could be implemented by the local agencies responsible for food waste management. The alternatives are structured to allow comparison of program approaches and are not intended to lead to a specific recommendation of an implementation approach. Rather, the comparison is intended to allow the involved agencies to understand the relative effectiveness of current management methods and the potential for changes that would make the management of food waste more economical and effective in meeting broader waste management goals and requirements.

For comparison purposes, the alternatives are assumed to have been fully implemented by the year 2000.

The quantities of food waste that can be diverted with implementation of these alternatives are a critical factor in determining the cost and effectiveness of the alternative. The objective in developing the diversion estimates is to provide a reasonable projection of what might happen based on the best available information. Unfortunately, compared to most issues associated with wastewater management, there is little experience on which to base the estimates. As noted in the case study section of the report there are no examples of communities making the kinds of changes considered in these alternatives. Only New York City has a related program and it has never allowed the use of food grinders so the situation is quite different. The next possible source of information would be surveys in which the served population is asked what they do now and how they would respond to

various situations. Information of this sort is available for commercial generators in the service area but not for residential customers.

The result of this situation is that the diversion estimates are based primarily on the experience and judgment of the investigators. This approach should be viewed as needing verification prior to implementation, but still a valid and necessary step in determining the potential for making positive changes in the methods used to manage food waste.

Table 4.2.1 provides the projected year 2000 food waste generation by category. These estimates are based on the information discussed in Section 2. The least well understood of the generator categories is food processors. Most of this material is currently reused in some way either through rendering or as animal feed. As such it has not been a part of the solid waste stream and not subject to waste composition quantification. Because these materials have historically been managed outside of the wastewater and solid waste management systems, they are considered to remain unchanged in all of the alternatives.

Table 4.2.1 - Year 2000 Food Waste Generation in the Metro Service Area			
	<i>West Point Wet Tons/yr</i>	<i>East Division Wet Tons/yr</i>	<i>Total Wet Tons/yr</i>
Residential	58,900	37,600	96,500
Food Wholesale/Retail	46,700	21,500	68,200
Food Services	63,400	27,400	90,800
<i>Subtotal</i>	<i>169,000</i>	<i>86,500</i>	<i>255,500</i>
Food Processors	138,000	35,600	173,600
<i>Total</i>	<i>307,000</i>	<i>122,100</i>	<i>429,100</i>

The estimated flow of food waste to each of the five identified management systems for each of the alternatives is presented on Table 4.2.2. The projections are for the year 2000 which allows a reasonable period of time for implementation. The current practice alternative also indicates the estimated 1995 flow pattern. The rationale for each of the food waste flow estimates is presented in the alternative discussions.

Table 4.2.2
Food Grinder Study
Year 2000 Diversion Estimates for Final Alternatives

Food Waste Quantities (Wet Tons / year)										
Alternative	Onsite Usage	Source Separated	Render Reuse	Sewer System		Landfilled	Total Food Waste		Percent of Total Food Waste To Sewer System	
	WT / yr	WT / yr	WT / yr	WPTP WT / yr	EDRP WT / yr	WT / yr	WT / yr			
1 Current Practice - Year 2000	3,000	27,000	156,000	32,400	19,400	192,200	430,000	430,000	12%	
2 Source Separated										
A. Commercial Only	3,000	75,000	156,000	27,300	17,200	151,500	430,000	430,000	10%	
B. Residential & Commercial	3,000	133,000	156,000	22,900	13,600	101,500	430,000	430,000	8%	
3 Maximum to Landfilling	3,000	27,000	156,000	5,200	3,000	235,800	430,000	430,000	2%	
4 Maximum to Sewer System	3,000	27,000	156,000	89,700	45,300	109,000	430,000	430,000	31%	
5 Maximum WP Diversion	3,000	87,000	156,000	5,200	19,400	159,400	430,000	430,000	6%	

Alternative 1 - Continuation of Current Management Practices

Description

- **Onsite** - The current practice includes two programs being evaluated by the City of Seattle and King County. Seattle is currently distributing "Green Cones" for residential food waste disposal. These cones are partially buried in the ground with a space provided for the food waste to degrade without negative impact from odor or vectors. The current program includes an educational / marketing program and distribution of 5,000 cones. It is projected that by the year 2000 about 38,000 cones will have been distributed. King County is exploring the effectiveness of on-site composting of food waste at commercial food service type businesses. At the time of this report, a draft report has been submitted to the County. The County will be implementing a demonstration at an institution to evaluate the effectiveness of on-site composting at that and similar sites. Based on projections for the City of Seattle Residential "green cone" distribution program. It is estimated that 38,000 green cones will have been distributed and the average food waste disposed will be 0.08 tons of material per year. No significant commercial onsite processing is included.
- **Source Separated Collection and Processing** - The current practice is for a portion of the produce waste from wholesalers and grocery stores to be separately collected and composted at existing yard debris composting facilities. Three local composting facilities are currently processing this fraction of the food waste. Major grocery chains such as Larry's, QFC and Safeway are currently involved and expanding participation in these programs. There is a significant cost incentive for these businesses to transfer from garbage disposal to composting. The service is offered by the business's garbage collection service, so the difference in cost is presented as a direct savings. These businesses also seem to prefer composting to sewer discharge although the economic incentive is not as clear. There also may be a perception that composting of food waste is more environmentally acceptable than sewer system discharge. Based on the currently available diversion of produce waste from the sewer system and landfilling to yard debris composting facilities. A significant cost savings is available and produce waste generators are rapidly changing management methods. It is expected that by 2000 this will be fully implemented and all produce waste (80% of the wholesale / retail food waste) will be diverted from half of the large generators.
- **Reuse** - The available information about food processing wastes indicates that it is currently being diverted primarily to reuse. Food processing wastes such as dairy, bakery and brewery wastes are being used for animal feed while meat and fish processing wastes are being sent to renderers. This process stream is the least understood in terms of quantities generated and reuse / disposal methods.

Assumes that 90 percent of the food waste processing waste is reused or rendered.

- *Sewer System Discharge* - Discharge of food waste to the sewer system is available without restraint for residential customers and with minimal constraint to commercial customers provided it is ground to 1/4" particle size. Food processors discharging high strength waste would be expected to have a permit and be paying a surcharge for treatment of the strong organic load. Other than these few constraints anyone can purchase a grinder and discharge food waste to the sewers. This is the base case estimate presented in Section 2 except that one-third of the wholesale / retail food waste that is discharged to the sewer system in 1995 is assumed to be diverted to composting by the year 2000 as a result of cost incentives now available to this commercial section.
- *MSW Collection and Landfilling* - Food waste can also be placed in the garbage collection containers. There is limited incentive for most customers to find cheaper or more environmentally appropriate options. The only available options for most customers is food grinder use or onsite processing. The potential benefits of food grinder use in reducing the garbage load has not been disseminated to the public. This option is probably recognized as a convenience rather than an economic and environmentally sound option to garbage disposal. All material that does not go to one of the other management systems is assumed to be landfilled.

Benefits and Impacts of Implementing Alternative 1

Continuation of current practice is the baseline condition for comparison with the other alternatives. Operating conditions at Metro treatment facilities would be as currently planned. Recycling of food waste would be implemented on a limited basis.

Alternative 2 - Source Separation and Collection of Food Waste for Processing

Description

Alternative 2 provides the option of diverting food waste from the sewer system and garbage collection to a separate collection and processing system. Processing would be by composting or anaerobic digestion.

- *Onsite* - The same availability of onsite processing and use would be provided as with Alternative 1. Food waste diversion is the same as Alternative 1.
- *Reuse* - The same availability of reuse would be provided as with Alternative 1. Food waste diversion is the same as Alternative 1.
- *Sewer System Discharge* - The same management methods are exercised as in Alternative 1 except that efforts would be made to divert food waste from the sewer system to the separate food waste collection program. Assumes that 33 percent of the food waste that would have gone to the sewer system is diverted to source separated collection.
- *MSW Collection and Landfilling* - An additional solid waste collection program is implemented for food waste. This might entail changes to the method of collecting other solid waste stream, such as the yard debris or garbage collection methods. For example a single truck might simultaneously pick up yard debris or garbage along with the food waste to improve the efficiency of the collection process. Educational and promotional efforts would be made to divert food waste from the garbage collection system to the separate food waste collection program. Everything that does not go somewhere else.

Alternative 2A - Only Commercial Food Waste Collection

- *Source Separated Collection and Processing* - A source separated commercial food waste collection program would be initiated by commercial haulers. The food waste would be hauled to a permitted processing site. The collection program would be started as the result of a lower cost tipping fee at a processing site dedicated to the treatment of food wastes. The reduced tipping fee would have to compensate for anticipated increased collection and transfer costs. The quantity of food waste that could be diverted would depend on the cost of collection routing together with processing. Larger generators that are centrally located would be the lowest cost and first to be diverted followed by smaller and more dispersed generators. This estimate is from the Seattle Commercial Food Waste Collection and Composting Demonstration Project. The estimate provided is for the base case situation from that report which assumes that food waste is collected only from large commercial generators (>26 tons per year).

Alternative 2B - Collection of Residential and Commercial Food Waste

- *Source Separated Collection and Processing* - The commercial sector would be served as described in the previous section. Residential food waste would be collected from homes in one of several ways. This estimate assumes the commercial load from 2A above plus diversion of 60 percent of the residential food waste generation through an active education and promotion effort.
 1. Together with yard debris
 2. Separately in a secure container
 3. Collected with yard debris or garbage but isolated in a bag that is later separated for processing.
- An additional solid waste collection program is implemented for food waste. This might entail changes to the method of collecting other solid waste stream, such as the yard debris or garbage collection methods. For example a single truck might simultaneously pick up yard debris or garbage along with the food waste to improve the efficiency of the collection process. Educational and promotional efforts would be made to divert food waste from the garbage collection system to the separate food waste collection program.

Benefits and Impacts of Implementing Alternative 2

Implementation of a source separation program for commercially and residentially generated food waste would be expected to divert food waste from both the sewer system and the garbage collection system. Diversion from solid waste management would increase recycling for the County and City. The quantity of biosolids and methane generated by the wastewater facilities would be reduced.

Initiation of new collection routes for food waste would be required, necessitating separation of another recycling fraction by homes and businesses. Siting of a new food waste processing facility would likely be required. Impacts of constructing and operating a new facility can be effectively mitigated. Permitting a new site might be difficult. The additional collection trucks would use fossil fuels and impact neighborhoods with increased noise and traffic.

Alternative 3 - Minimum Food Waste to the Sewer System

Description

This alternative assumes that the primary objective is to divert food waste away from the sewer system to minimize the load on the treatment plants and extend the period until the facility needs to be expanded. Facilities expansions are primarily driven by hydraulic loading, but solids loadings are important in expansion considerations.

- ***Onsite*** - The same availability of onsite processing and use would be provided as with Alternatives 1 and 2. Food waste diversion is the same as Alternative 1.
- ***Reuse*** - The same availability of reuse would be provided as with Alternatives 1 and 2. Food waste diversion is the same as Alternative 1.
- ***Sewer System Discharge*** - The maximum effort would be made to divert food waste from the sewer system to the garbage collection program. The minimum diversion to the sewer option is assumed as discussed in Section 2.
- ***MSW Collection and Landfilling*** - There would be no changes in programs or policies. Educational and regulatory actions would be taken to minimize the discharge of food waste to the sewer system and to encourage disposal in the garbage collection system. Everything that does not go somewhere else is directed to the landfills.

Benefits and Impacts of Implementing Alternative 3

Diversion from the sewer system would extend the time that the current solids processing facilities can provide service without expansion. The quantity of biosolids and methane generated by the facility would be reduced. Recycling percentages would be reduced because new solid waste tonnage would be generated that has not been counted as solid waste in the past and would then be collected and disposed of at the landfills. No new facilities would be required. The projected operating life of the landfills would be reduced.

Alternative 4 - Maximum Food Waste to the Sewer System

Description

This alternative considers the management approach that encourages discharge to the sewer system as an effective method of managing food waste. The primary focus is diversion from the solid waste stream (currently collected as garbage and taken to the landfill).

- *Onsite* - No new programs would be proposed. Food waste diversion is the same as Alternative 1.
- *Source Separated Collection and Processing* - No new programs would be proposed. Food waste diversion is the same as Alternative 1.
- *Reuse* - No new programs would be proposed. Food waste diversion is the same as Alternative 1.
- *Sewer System Discharge* - Use of food grinders would be encouraged through education programs and rebates or other incentives for installation and use of grinders. The maximum diversion to the sewer option is assumed as discussed in Section 2.
- *MSW Collection and Landfilling* - Prohibitions on disposal with solid waste of suitable materials. Everything that does not go somewhere else is directed to the landfills.

Benefits and Impacts of Implementing Alternative 4

Maximizing food waste discharge to the sewer system would greatly increase the organic loading on the treatment facilities. If the diversion program was very successful, then enlargement of the solids processing system would be required much sooner than currently planned. The quantities of biosolids and methane produced would increase. Recycling percentages achieved by the solid waste agencies would increase.

Alternative 5 - Minimum Food Waste to Sewers in the West Point Service Area

Description

The objective is to reduce the impact of the West Point Treatment Plant on the neighboring community. The proposed method of achieving these goals is to encourage the source separation, collection and processing of residential and commercial food waste from this area. This would assist in reducing the loading to West Point Treatment Plant (and the resulting community impacts such as digester capacity and truck traffic). This alternative would also include an education program aimed at reducing grinder use in that service area.

- *Onsite* - No new programs would be proposed. Food waste diversion is the same as Alternative 1.
- *Reuse* - No new programs would be proposed. Food waste diversion is the same as Alternative 1.
- *Source Separated Collection and Processing* - A complete residential and commercial food waste collection program is initiated throughout the West Point service area. Food waste diversion in the EDRP service area is the same as for Alternative 1.
- *Sewer System Discharge* - Use of grinders is discouraged in the West Point service area through an education program. Food waste that was discharged to the sewer becomes garbage or source separated and collected organics.
- *MSW Collection and Landfilling* - Placing food waste in garbage is discouraged or prohibited. Everything that does not go somewhere else is diverted to the landfills. The landfilled food waste quantity is lower than Alternative 1 because the source separation and collection program compensates for the quantities that were discharged to the sewers.

Benefits and Impacts of Implementing Alternative 5

Minimizing food grinder use in the West Point service area would decrease the loading on the digesters and reduce the quantity of biosolids generated. Implementation of a source separation program for commercially and residentially generated food waste would be expected to divert food waste from both the sewer system and the garbage collection system. Diversion from solid waste management would increase recycling for the County and City. The quantity of biosolids and methane generated by the West Point facilities would be reduced.

Initiation of new collection routes for food waste would be required, necessitating separation of another recycling fraction by homes and businesses. Siting of a new food waste processing facility would likely be required. Impacts of constructing and operating a new facility can be effectively mitigated. Permitting a new site might be difficult.

The BOD and TSS loadings and concentration of wastewater influent to West Point Treatment Plant would be reduced.

4.2.1 Approximate Costs for Non-Sewer Management Options

Based on preliminary estimates, planning level costs (+40% to - 25%) have been developed for each management system.

- *Onsite* - The cost of \$94 per wet ton of food waste is based on the current "green cone" program currently being implemented by the City of Seattle. The estimate is based on a total cost for education, distribution and materials of \$64 per cone distributed, a service life of 10 years and diversion of 0.08 tons per year of food waste per cone distributed.
- *Source Separated Collection and Processing / Produce Waste* - This cost of \$66 per wet ton is based on current collecting and composting charges to grocery stores.
- *Source Separated Collection and Processing / Commercial Food Waste Composting* - Based on the Seattle Commercial Food Waste Project, the estimated base case collection and composting cost is \$90 per ton.
- *Source Separated Collection and Processing / Residential and Commercial Food Waste Composting* - Again based on the Seattle Commercial Food Waste Project, the estimated average collection and composting cost for commercial and residential food waste is \$86 per ton.
- *Reuse* - The cost of reusing food processing waste is not known. Discussions indicate that renderers used to pay for some wastes but that is decreasing. The assumption used is that the materials are now and will continue to be given away at no cost. An allowance of \$10 per ton is included for transportation to the reuse site.
- *MSW Collection and Landfilling* - The cost of collecting and landfilling of MSW is not readily available from the City of Seattle or King County. The basis for the cost of residential disposal is a Clean Washington Center Report D2: The Economics of Recycling and Recycled Materials by Sound Resource Management Group, 1993. This estimates the cost of residential collection and landfilling at

\$137 per ton. The total cost of collecting and landfilling commercial solid waste is estimated in a City of Seattle Report: Review and Analysis of Local Regulatory Options: Improving the Efficiency and Effectiveness of Commercial Garbage Collection by Ecodata, Inc., 1994. This report estimates the average cost of commercial collection and disposal as \$131 per ton. By quantity weighting these costs an average commercial and residential cost of \$135 per ton was developed.

4.3 Alternative Comparison

A preliminary, focused comparison of alternatives is provided which considers three factors of primary significance to Metro:

1. The quantity of food waste discharged to the Metro sewer system
2. The loading that this food waste generates on the treatment process unit loading
3. The preliminary operation and maintenance cost associated with processing food waste.

Table 4.3.1 shows the treatment facility loadings that would result from implementing the food waste management alternatives. The alternatives offer a wide range of loadings.

Table 4.3.1 Comparison of Treatment Facility Loading for Alternatives (Year 2000)						
<i>Alternative</i>	<i>FW to Metro Facilities (dry tons/yr)</i>		<i>Primary TS load from FW (dry #/day)</i>		<i>Secondary BOD load from FW (dry #/day)</i>	
	<i>WTPP</i>	<i>EDRP</i>	<i>WTPP</i>	<i>EDRP</i>	<i>WTPP</i>	<i>EDRP</i>
1. Current Condition	8,600	5,075	4,900	2,900	3,700	2,200
2. Source Separation	6,825	4,300	3,900	2,500	2,900	1,850
3. Minimum to Sewers	1,300	750	740	430	560	325
4. Maximum to Sewers	22,400	11,300	12,800	6,400	9,600	4,900
5. Minimum to West Point	1,300	5,075	740	2,900	560	2,200

Table 4.3.2 provides a comparison of the loading and cost of processing at the treatment facilities for each of the alternatives.

Table 4.3.2 Comparison of Treatment Facility Loading and Cost of Alternatives				
<i>Alternative</i>	<i>FW to Metro Facilities (Year 2000) (dry tons/yr)</i>		<i>Preliminary Wastewater Treatment Operational Cost (\$10⁶ per year in 2000)</i>	
	<i>WTPP</i>	<i>EDRP</i>	<i>WTPP</i>	<i>EDRP</i>
1. Current Condition	8,600	5,075	\$2.0	\$0.8
2. Source Separation	6,825	4,300	\$1.6	\$0.6
3. Minimum to Sewers	1,300	750	\$0.3	\$0.1
4. Maximum to Sewers	22,400	11,300	\$4.0	\$1.5
5. Minimum to West Point	1,300	5,075	\$0.3	\$0.8

The cost of treatment increases with the quantity of food waste being discharged to the sewer system. The analysis indicates that the lowest cost alternative from the standpoint of Metro operations is to minimize use of food grinders and the resulting discharge to the

sewer system This alternative also preserves constructed capacity at the treatment facilities and reduces digester loading at the West Point treatment facility.

4.4 Conclusion

This evaluation resulted in the following findings and conclusions:

1. Food waste currently discharged to the sewer system represents about 14 percent of the food waste generated in the Metro service area.
2. Food waste discharged to the sewer system is estimated to currently represent about 15 to 18 percent of the organic loading on Metro treatment process units.
3. Food waste is a relatively clean and highly degradable material. Food waste originated material would be expected to digest rapidly with high methane production and would be readily removed in the secondary treatment process.
4. Reducing the discharge of food waste to the sewer system would have the following effects:
 - minimal impact on the quality of biosolids, although metals contents would be expected to increase somewhat.
 - minimal impact on effluent quality requirements, although the 85% removal criteria may result in a somewhat lower effluent BOD concentration requirement at the West Point Treatment Plant (WPTP).
 - An extension of the time before treatment facility expansion is required.
5. Increasing the discharge of food waste to the sewer system would have the following effects:
 - Food waste is a potential source of significant unanticipated organic loading.
 - Some dilution of the metals in biosolids.
 - Increased gas production.
 - Higher organic loading on the West Point facility that could potentially raise the facility BOD concentration above 200 mg/L.
6. Management of food grinder usage was not found to be practiced in the United States as a solid waste management method.
7. Estimated costs for non-sewer management options
 - Onsite: \$94 per wet ton
 - Grocery produce waste to yard debris compost facility: \$66 per wet ton
 - Source separated commercial FW collection and composting: \$90 per wet ton
 - Rendering and Reuse of food processing waste: about \$10 per wet ton

- **Collection and Landfilling:** \$135 per wet ton

4.5 Areas of Future Study

This feasibility analysis has identified several issues that should be addressed if the management approaches considered will be pursued. Many of the issues relate to the limited information available on many of the assumptions used in the evaluation. A reliable analysis of the benefits that can be developed from a management change requires better information. The following recommendations provide specific information needs and actions that would give a strong basis for action.

Understanding of the Issue

- Little definition information is available on residential food waste grinder installation and usage in the Seattle area. A residential use survey would provide valuable information that could be used to determine current use and attitudes about changes in food waste handling.
- Food processors and their current and potential impact on wastewater and solid waste management systems is not well understood. An evaluation of who they are, what and how much waste they produce, current disposal methods, and what would drive a change in their behavior should be completed. Metro should consider the risk of significant future discharge of this large volume of organic wastes in the future.
- The cost impacts of diversion from one waste management system to another is not known. Fixed costs would likely reduce the economic benefit of a diversion. The cost effectiveness of the alternative management approaches considered in this report may be lessened as a result of fixed costs in other programs. The impact of these costs should be determined.
- The cost of installing and operating a food waste grinder (including sewer services charges) should be determined and compared directly to the costs of solid waste disposal.

Reduction of Loading at West Point

- The public (residential) support of diversion of food waste from West Point is not clear. The public response to a call to change practices based on the need to reduce loading should be evaluated through the previously recommended survey format.

- Likewise, the reuse of food processing waste should be considered recycling. Inclusion of this waste stream in the solid waste and recycling accounting procedure may be beneficial.

Intergovernmental Coordination

- A coherent policy on food waste disposal will require the cooperation and coordination among all governmental agencies within the Metro service area. Metro KCSWD, Seattle Solid Waste Utility, and the suburban city solid waste entities will need to have programs and policies that send a consistent message to the customer about how to dispose of food waste. For example, if Metro wants to promote the usage of food grinders, the solid waste agencies would not promote curbside collection of food waste if the overall program would not be effective. Coordination among governmental agencies can be accomplished in a variety of ways, such as an expanded task force composed of agency representatives working in a facilitated situation to arrive at common objectives and compatible actions. A comparison matrix similar to that presented in Appendix F could be used to rank any alternatives developed.

Regulatory Adjustments

- Effective regulations are a requirement for implementing a coherent food waste management policy. The existing policies and regulations of agencies involved in permitting composting facilities need to be clarified and any uncertainties considered. Specific issues that need to be resolved are Health Department requirements for control of vectors and protection of the public health, PSAPCA requirements for odor control and WDOE requirements for runoff control.

Solid Waste Collection

- Develop food waste source separation programs for high density areas of Seattle and King County.
- Better understanding of collection / diversion economics should be developed.
- Better information on total costs of solid waste management should be developed

Food waste processing

- **An evaluation of commercial food waste digestion technologies and the potential for implementation in the Seattle area should be completed.**
- **A food waste composting process optimization evaluation should be completed. A proposal has been submitted by Cedar Grove Composting, Inc. and E&A Environmental to the Clean Washington Center for this purpose.**

References

- ¹ *Food Waste Collection and Composting Demonstration Project, Assessment of Commercial Food Waste Generation and Source Separation Feasibility Study*, City of Seattle Solid Waste Utility, E&A Environmental Consulting, Inc., The Matrix Management Group, and Elway Research
- ² The model is based on FAZs -- Forecast and Analysis Zones -- developed by the PSRC.
- ³ PSRC provides forecasts for five sectors including, retail; finance, insurance, and real estate; government; wholesale, transportation, and communication; and manufacturing. The retail and manufacturing rates were chosen because they most closely match the activities of the generating sectors under consideration.
- ⁴ *Program Evaluation for Seattle Food Waste Composting Pilot, Final Report*, City of Seattle Solid Waste Utility, Cunningham Environmental Consulting, Inc. and C2S2 Group, January 1993.
- ⁵ Seattle-King County Department of Public Health, Dick Johnson, Chief Plumbing Inspector.
- ⁶ A commonly used "best case estimate" for waste diversion through a specific management method, e.g., curbside recycling of plastic bottles.
- ⁷ *Food Waste Collection and Composting Demonstration Project, Assessment of Commercial Food Waste Generation and Source Separation Feasibility Study*, City of Seattle Solid Waste Utility, E&A Environmental Consulting, Inc., The Matrix Management Group, and Elway Research, Inc., 1993.
- ⁸ *Food Waste Generation Verification Study*, City of Seattle Solid Waste Utility, Cascadia Consulting Group, 1994.
- ⁹ *Food Waste Collection and Composting Demonstration Project, Assessment of Commercial Food Waste Generation and Source Separation Feasibility Study*, City of Seattle Solid Waste Utility, E&A Environmental Consulting, Inc., The Matrix Management Group, and Elway Research, Inc., 1993.
- ¹⁰ *Food Waste Collection and Composting Demonstration Project, Assessment of Commercial Food Waste Generation and Source Separation Feasibility Study*, City of Seattle Solid Waste Utility, E&A Environmental Consulting, Inc., The Matrix Management Group, and Elway Research
- ¹¹ Finger, Dick. Memo dated 10/12/94
- ¹² Metro Long-Range Strategic Biosolids Plan, Task 3. 8/20/94.
- ¹³ "Biosolids Estimates for Long-Range Planning" Metro Memo to V. Fischer from M. Poling, 10/31/94
- ¹⁴ Poling, Mark. Biosolids Estimates for Long-Range Planning Memo dated 8/31/94.
- ¹⁵ BOD Values in Task Memo 3.1 are for secondary influent. This analysis assumed total influent BOD equals secondary influent plus 36% which would have been removed in primary treatment.
- ¹⁶ Strutynski, Barbara. Interview 12/13/94
- ¹⁷ WPTP Unit Process Report: Primary Treatment. Jan. '94 - Nov. 30, '94.
- ¹⁸ 2005 Production Plan, Biosolids Management Program. 8/94. Lucas, Mark
- ¹⁹ Adapted from Task 3.4 & 3.5.
- ²⁰ Commercial Food Waste Collection and Composting Demonstration Project, Vol. IV, King County Department of Public Works, June 1994
- ²¹ 2005 Production Plan, Biosolids Management Program. 8/94. Lucas, Mark
- ²² Adapted from Task 3.4 & 3.5.
- ²³ Commercial Food Waste Collection and Composting Demonstration Project, Vol. IV, King County Department of Public Works, June 1994
- ²⁴ 2005 Production Plan, Biosolids Management Program. 8/94. Lucas, Mark

